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FIG. I. CUTTING AWAY FOR NEW WHARVES, SYDNEY, AUSTRALIA.

ROCK EXCAVATION AT SYDNEY HARBOR AUSTRALIA

The New South Wales Government dockyard is situated on Cockatoo Island, in Sydney Harbor. It is on the site of a large prison established in the days when British convicts were transported to Australia. The formation of the island was originally quite unsuitable for a dockyard, as the solid rock rose sheer from the water to a height of 60 to 70 feet. By the use of convict labor the rock was gradually cut back, first to permit the building of graving docks and later to make room for building slips and shops near water level. This work has been and is being continued until at present two-thirds of the total area of 33 acres has been brought to a practically uniform level of about 15 feet above high tide. The two accompanying halftones show how the work is now being carried on, rock drills being employed, but the arrangements for handlng the material being still antiquated and inefficient.

What follows is communicated to Com-

PRESSED AIR MAGAZINE by Mr. A. P. Smith, of Sydney, who wishes to make record of his indebtedness to Mr. Debenham, one of the engineers of the Harbor Board for much of the information here given.

SUBMARINE ROCK EXCAVATION.

To make the dockyard and other facilities fully available, and in general to keep pace with the increasing draft of modern ships, it has been found necessary to extensively excavate the harbor bottom in the main channels and along the principal wharfs.

The material for the most part consists of sand and silt resting on a sandstone bottom, which rises at the shores to form the hills which are the chief feature of the harbor scenery. And while in the main channels, suction, bucket and grab dredges are all that are necessary to remove the material, these excavators become useless along the foreshores where the rock crops up.

To remove the rock several methods have been tried. Drilling and blasting with isolated drills proved too expensive and the Loebnitz rock crushing system was a failure. The machine that has been employed for some years now by a contractor is a rock-chopper, which consists of a large drill, boring 18" holes in diameter, and with this machine no explosives are used, the rock being cut out by a series of holes pitched close together. But the price asked by the contractor for this work has been considered too high by the Harbor Trust, who decided to build and use a drilling and blasting plant on modern lines—a description of which follows:

Four drills are mounted on a pontoon, Fig. 3, whose measurements are 80'x30'x6', on one side of which there is a gantry consisting of seven "A" frames braced together. Along the top of these frames runs an 8"x6" Oregon beam carrying a 40 lb. rail. Another 40 lb. rail rests on a sill on the deck, and these two rails carry the four drill frames which run along the rails on double flanged wheels, the total height of the drill frame being 24 feet. These drill frames can be moved along the gantry to any desired position and clamped, and the drilling machines slide up and down inside these frames, being hoisted or lowered by means of block and tackle taking their lead to one of two winches located at the end of the pontoon. The machines are pinned as desired by attachment to a chain passing behind the machines and fastened to the top of the frame. Two sheaves are situated at the top of each frame, one takes the rope for raising and lowering the machine, and the other a rope for removing and replacing steel.

The plant on the punt consists of two Colonial type boilers, an "A-1" Ingersoll-Rand air compressor, 18x18¼x24, having, at 100 r.p.m., a piston displacement of 656 cubic feet of free air per minute, a steel air receiver, 16' 3"x3' 9", two 10"x6" Marine type Winches with drum and two winch heads, two Tangye pumps 5"x5"x12" which supply the circulating water for the air cylinder jackets and water jets for cleaning drill holes, two donkey feed pumps 4"x4" for boiler feed, two three thousand gallon tanks built in underneath the decks, and opposite the boilers a large coal bunker and tool bench.

The pontoon is moored by four spuds and six kedges, two 4 cwt. each and four 2 cwt. each. The whole pontoon is covered by a lean-to galvanized iron roof.

The drill sharpening is done in a separate punt, 53' 6"x23' 6"x3' 6" fitted with forge and anvil, the forge being worked by a hand blower or hose from the air receiver. This punt is moored along the front of the pontoon and kept off by fenders. The blunt drills are lowered on to the punt and picked up by chain block and tackle which is suspended from a "crawl" running on two rails hung from cantilever supports. By balancing the drill in this tackle it is easily moved about from the forge to the anvil.

The drill outfit consists of four "HA-3" Ingersoll-Rand drills 5" cylinder by 8" stroke. The depth of holes bored is from 7' to 20', diameter of bit; starting, 4½" and finishing at 3½", spacing the holes six feet centres laterally and longitudinally. The drill steel consists of 2½" mild steel shanks with 12" of 3" cruciform (heavy section) bit of high-grade Andrews tool steel welded to the end. This bit is splayed out to a cutting edge of 4½" width.

The explosives used are Rackarock and Gelignite, 60%, the cartridges being 2¾"x6", 9" and 15" long, the charge for a 7' hole being about 5 lbs. A sand pipe is used consisting of a cast steel pipe 8" at the top and tapering to 5" at the bottom with a lug for chain attachment. This is lowered into place after collar of hole is cut, and serves the purpose of keep-

ing the hole free from sand and silt, etc. A ¾" nozzle from the pumps is kept going to free the hole from drillings.

When the hole is completed the drill is withdrawn and a galvanized pipe 3" in diameter is lowered into the hole. The pipe is in sections and the total length is such that it stands above the water level. Down this pipe is passed a 1" hydraulic nozzle which thoroughly cleans the hole out. The cast steel pipe is then withdrawn and the hole charged. These galvanized iron pipes are left in place and recovered after the hole is fired, any damage being repaired by the tinsmith.

The operation of the drilling pontoon consists in drilling a range of holes along the whole length of the pontoon, charging them and then hauling off the punt and exploding the charges. After this, the pontoon is brought back into place and another range of holes drilled and fired, a grab dredge being used for removing the rock.

The nature of the rock is yellow sedimentary sandstone varying in hardness in different localities. The drilling is done in from four to thirty-five feet of water. A set of drills consists of one 20', two 30', two 35', two 40' and two 45', the final hole being drilled 2' 6" below the depth desired.

"POTTING FOR PILES."

When there is less than ten feet of sand on top of the rock it is necessary to "pot" the piles into the rock. This is done by a separate drilling plant consisting of a 5½" and a 6½" (on order) Ingersoll-Rand drill which is worked by steam in the leaders of the pile frames. The drill frame is raised or lowered in the leaders by a wire rope attached to the pile frame winch. The drill steel consists of a 1¾" mild steel bar, to the end of which is welded a socket which forms the attachment for a crosshead and pilot bit. This crosshead has four holes into which are cottered four chisel bits 6" face, the chisels being placed radially. The diameter of the hole drilled is about 16" and the usual depth is 4' 6", into which the pile is driven with the aid of a hydraulic jet, the sand afterwards filling in and grouting the pile into place. This is quite different from any other practice known here,

FIG. 2. CUTTING AWAY FOR ROAD TO WHARVES, SYDNEY, AUSTRALIA.

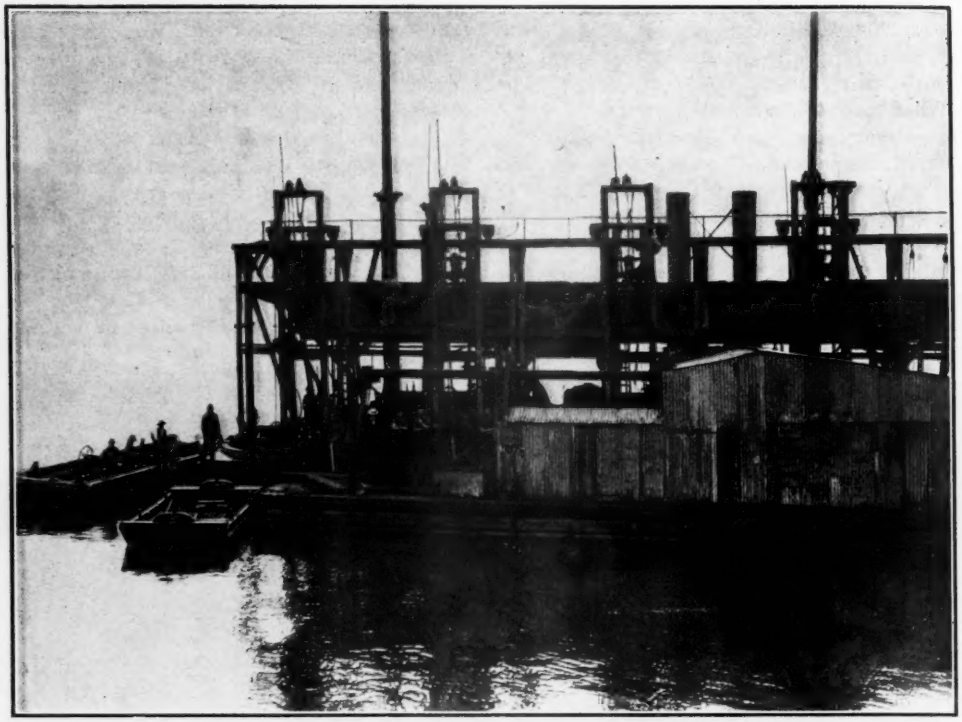


FIG. 3. PONTOON FOR SUBMARINE DRILLS, SYDNEY HARBOR, AUSTRALIA.

the average speed of drilling being from one to three holes a day, depending on the amount of overburden of sand or silt. When more than 2′ 6″ of sand or silt is met with it is necessary to use a cylinder to keep the sand out of the hole. Hydraulic jets are always used in drilling these holes.

OTHER USES OF COMPRESSED AIR.

Compressed air is also used for driving pneumatic wood boring tools for boring holes in decking and girders and caps, the holes varying in diameter from ⅜″ to 1¼″ and the depth of holes from 8 in. to 2 ft. in hard wood. The rate of boring, 1⅜″ holes 3 ft. in five minutes of actual drilling time. The same plant, which consists of an Ingersoll-Rand, Type "NF-1" 8x8x8 steam driven air compressor with a 30.1 H. P. Colonial type boiler on a floating punt which is moved about the harbour to the different jobs as required is also used for drilling holes in metal. The tools used are Ingersoll-Rand "Imperial" No. 11 wood boring tools and "Imperial" No. 21 metal boring tools. The same compressor plant is also available for running two "Jackhamers" when it is necessary to drill holes in rock close to the water, and could also be used for operating sand rammers for ramming concrete later on.

All of the compressed air plant used by the Sydney Harbour Trust is of Ingersoll-Rand manufacture, both for rock excavation on land and subaqueous drilling.

STANDARD RATES OF WAGES (8 HOURS) ON SUBAQUEOUS WORK.

Shift boss	13/—
Drill men, four	each 10/—
Drill assistants, four	each 9/8
Engine driver	10/—
Stoker	9/8
Powder monkey	10/6
Blacksmith	10/—
Blacksmiths' strikers, two	9/—

Present rates of wages are in a state of transition owing to unsettled labor conditions and they will probably be higher.

A committee has been formed in England for standardizing and co-ordinating the diverse methods in use for determining the degree of pollution of the atmosphere by dust and soot.

THE UNDERGROUND BLACKSMITH SHOP

BY WARD BLACKBURN.

The mining engineer, to meet the increasing cost of operating due to the extension or spreading out of the underground workings, and incidentally to maintain his place in the ranks of the "Scientific Management Engineers," has begun to take advantage of every promised saving in mining operations. One of the latest schemes, and rapidly growing in favor, is the underground blacksmith and repair shop. While the underground shop is not a new idea, it has only been within the past few years that it has received the consideration its efficiency merits. Its adoption has undoubtedly been hastened by the introduction of the light, compact, easily moved power sharpeners, and the attention they have directed toward blacksmithing economies. Now many mines throughout the world are installing complete shops at convenient points underground. Some of the deeper mines, because of transportation difficulties, were the first to feel the need of keeping the rock drills and steel below the surface, but the underground shop has been found to possess so many advantages that it is being utilized even in the shallow mines where the workings are but 200 feet to 300 feet deep.

The chief advantage of the underground shop lies in the fact that transportation costs are reduced to a minimum. The shops are located on the principal levels and there is very little hoisting or lowering of drills or steels necessary. Isolated work on different levels is taken care of by small hoists in old stopes or air shafts, and the main hoisting shafts are left clear for handling the ore. Some mines now sharpening underground report that formerly 30 to 40 minutes were required per shift to hoist and lower steel. This did not represent the total time lost in handling, for in some cases a central shop was used and all steel had to be trucked to and from the shafts on the surface as well as below. The lost time and expense incident to handling steel in the shaft amounted to a considerable item in each month, but in most cases the serious complaint was against the reduction of the time allowed for hoisting ore and waste.

Localization of sharpening has been another factor to consider, for it has been found in some of the larger mines that the varying character of the rock precludes the dressing and tempering of all the steel in a central surface plant. Steels treated for the rock in one part of the mine would find their way into other parts and cause confusion and sometimes the loss of drill holes. With separate shops installed underground close to the workings, the blacksmith handles steels for only one kind of rock, and having an opportunity to inspect that rock he is better able to turn out correctly dressed and tempered steels. Putting the blacksmith right down in the midst of operations, brings in a personal element which is usually desirable, for, coming in contact with the runners, the smith will endeavor to please them and will take a greater interest and more pride in making his steel stand.

Having the blacksmith shop underground saves a great deal of time in getting steels and insures the drillers having proper steels when needed. If the machine man breaks a couple of steels it is only necessary for him to send the helper along the level to the shop for more. No time is wasted and work is not held up. This results in more drilling per machine per month. When the steel stays underground it may be distributed more frequently and consequently a smaller stock is necessary.

Under average conditions the advantages of the underground shop are found to be:

Saving in labor and hoisting charges. In deep mines these charges have been found to equal one-half of the total sharpening charges.

Reduction in transportation cost.

Steel kept out of shafts.

More time for hoisting ore and less chance of accident.

Localizing of sharpening. This gives proper steel for each class of work and promotes a better feeling between the runners and the blacksmith.

Steels when wanted and where wanted.

No time lost waiting for steel, either on the part of the machine men or blacksmith.

Less stock of steel required.

Blacksmith as available for repair work and odd jobs.

Men stay underground.

The location of the shop underground will naturally vary with conditions of convenience and ventilation. A place near a hoisting shaft is desirable; often an old stope connected to an air shaft or to the surface by an old pros-

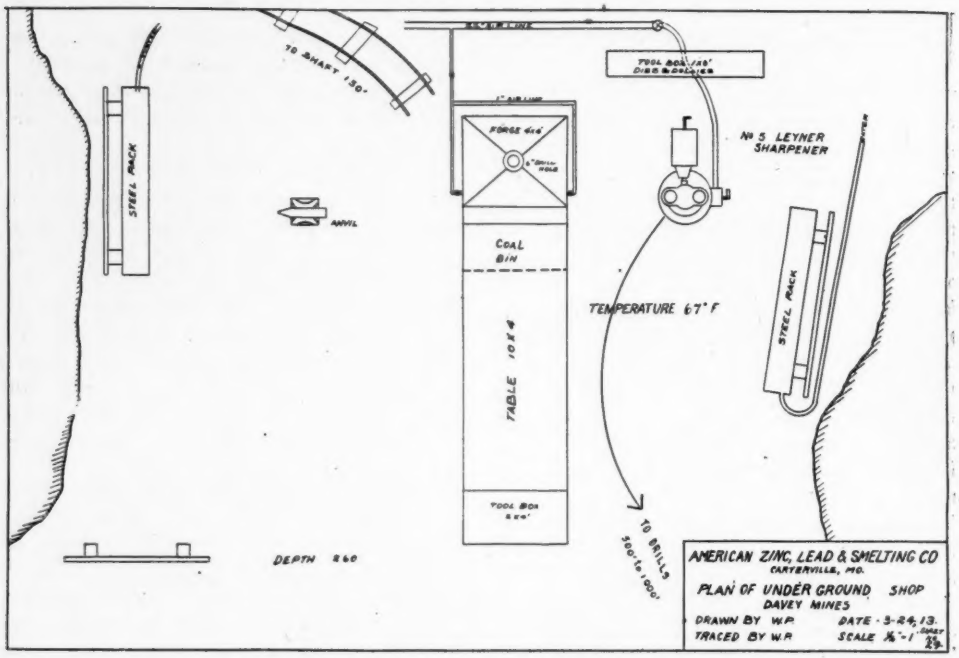


FIG. I. UNDERGROUND SHOP WITH CENTRAL FORGE.

pecting hole is utilized. Some mines have shops installed in widened drifts or cross cuts. As a rule it is best to stay near a shaft and preferably an updraft shaft.

About the same equipment that is used on the surface is found in the underground shop. As very little steel is now sharpened by hand, the first thing to select is a proper sharpener; a light, compact, easily moved machine, one requiring no foundation is especially desirable, for as development progresses it will be necessary to move the blacksmith shop. The machine selected should make the sharpening as nearly automatic as possible and it should be one easily controlled.

It has been demonstrated that one of the best ways to heat drill steels in the underground shop is by means of an oil furnace and there are now several excellent furnaces on the market designed especially for heating bits. This type of furnace takes up very little room, gives a good uniform heat, and when properly adjusted gives off very little smoke and gas. The oil furnace throws out no obnoxious fumes, for perfect combustion is obtained. The furnace is controlled instantly, and in emergency can be extinguished by simply closing a valve. This eliminates the danger from fire. The amount of oil required is nominal and the expense correspondingly low.

Suitable tempering facilities are sometimes hard to find for it may be inconvenient to have running water in the shop. In such cases the best results are obtained by having two or more large tanks, using them alternately and keeping the temperature of the water fairly low.

It is essential to provide suitable means for lighting the shop. If this is not done poor steel will result, and, further, the capacity of the shop will be kept low. Either acetylene gas lamps or Tungsten electric lights may be used to advantage, either giving a good light for blacksmithing purposes. It is easier for the blacksmith when sharpening underground to maintain uniform steel where the light is always the same, and when he can always tell within a few shades of color what the heat of the steel is. Ventilation must be carefully investigated, especially if the shop is located any distance from an up-draft shaft. Probably half of the blacksmith shops are located so that no special apparatus is necessary, the exhaust from the sharpener supplying plenty of fresh air and tending to force the heated air from the shop.

An excellent arrangement for an underground shop is shown by the sketch Fig. 1,.

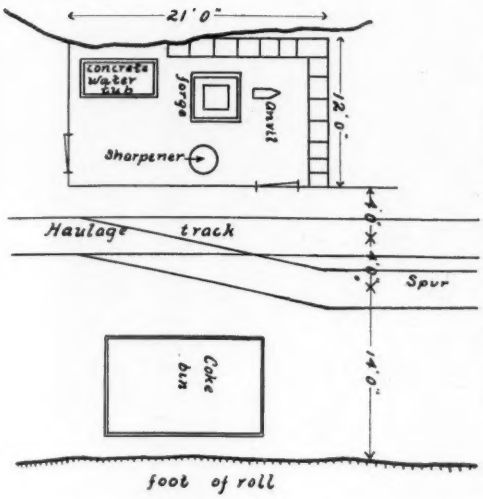


FIG. 2. SHOP AT JOKER MINE.

which was kindly furnished by Mr. J. N. Hansen, Manager, Missouri Mines of the American Zinc, Lead & Smelting Co., Carterville, Mo. The shop is ventilated by means of a 6-inch drill hole from the surface and a temperature of 67 degrees Fahr. is maintained. Mr. Hansen sums up the advantages of the shop in the saving of hoisting steel, in the blacksmiths being available for odd jobs of repairing underground and no waiting for steel on the part of the machine men.

Sketch Fig. 2 shows the underground blacksmith shop at the "Joker" mine of Witherbee Sherman & Co., Inc., Mineville, N. Y. Mr. Harry Comstock, Assistant General Manager, very kindly supplied this sketch and also the photographs, the first of which, Fig. 3, gives a good idea of the convenience of location of the shop shown in sketch Fig. 2. Fig. 4 shows the arrangement inside the shop proper. Being close to the shaft no ventilating apparatus is required and the temperature is approximately 60 *degrees Fahr.*

In the Barton Hill Tunnel property Mr. Comstock has placed the shop on the tunnel level, but near an old shaft connecting to the surface. Although a coke forge is used the ventilation secured is sufficient to carry off all fumes and maintain a temperature of about 70 degrees Fahr. Fig. 5 is a photograph of this shop, and with the sketch shown in Fig. 6 gives a good idea of a desirable arrangement of forge and sharpener. Both shops shown are lighted by incandescent lights, a lamp being placed directly over and in front of the crosshead of the sharpener so that the operator can watch the forming of the bit.

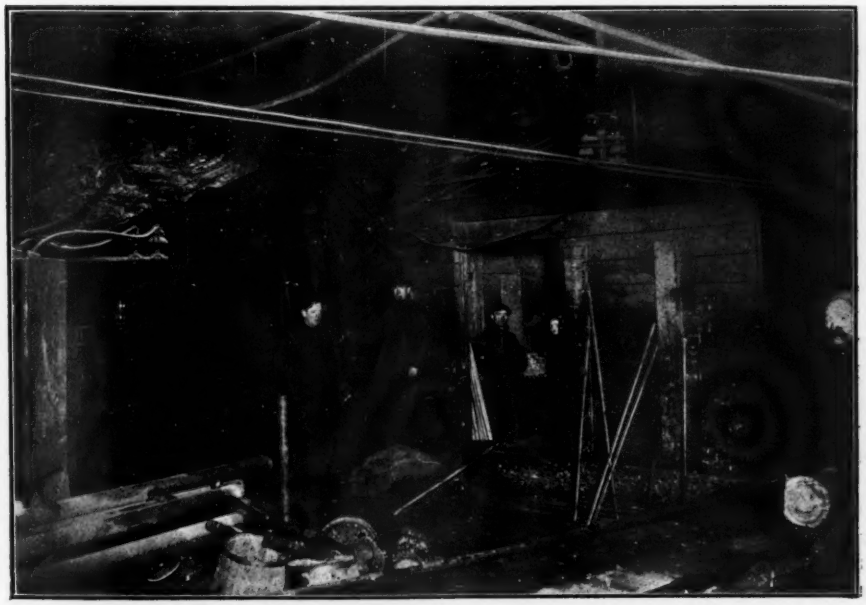


FIG. 3. SHOWING CONVENIENT LOCATION OF SHOP.

FIG. 4. INTERIOR OF SHOP IN JOKER MINE.

The Witherbee Sherman Co. installed the first sharpener underground early in 1912, and since then has purchased three more machines, Mr. Comstock's statement being that "The underground sharpener is proving very satisfactory and we would not consider any other arrangement. The costs are lower and the shop is convenient to the work." He has carefully prepared detailed cost sheets showing the total cost of sharpening per machine drill per month in the underground shop to be $8.20 over a period of nine months. The total cost of sharpening per drill per month for the central plant located on the surface, using backing block sharpeners, was $11.48 over a period of eight months.

From present indications it appears that in the near future an increasing number of mines will adopt the underground shop. Only one mine is known to have re-established the central shop on the surface after sharpening underground, and the reasons for so doing were stated to be because of the peculiar distribution of the work, it being possible to sharpen for only a few drills at any one place underground.

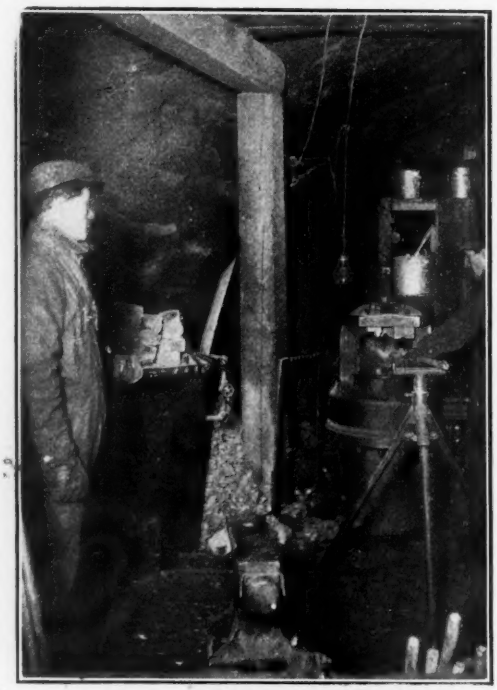


FIG. 5. BARTON HILL TUNNEL SHOP.

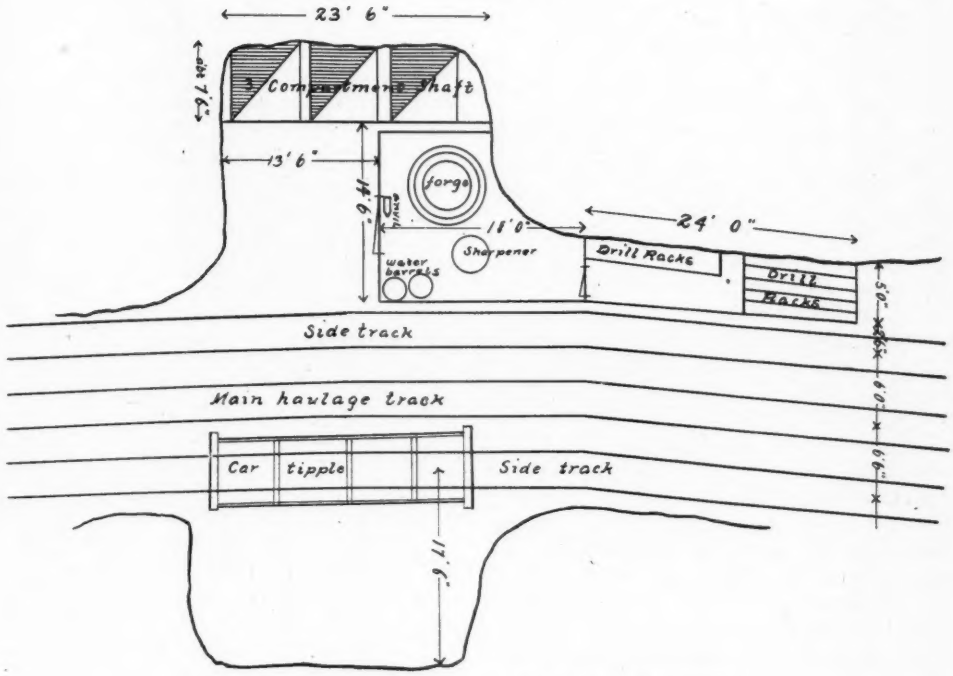


FIG. 6. DESIRABLE LOCATION OF FORGE AND SHARPENER.

EFFICIENCY IN MINING DRILL

BY ANDRE FORMIS.*

In consequence of the increased cost of labor and supplies in the process of mining it has become advisable to investigate the various steps in the production of tonnage with a view to reducing waste factors to a minimum. The paper submitted this evening aims to bring out a discussion on the subject of rock-drilling, the most important of the underground operations.

Considering that the labor factor in mining is about 75% of the total cost, it is evident that the savings effected in this item are proportionately of greater importance than in the matter of the other 25% of the cost. However, owing to the nature of this larger factor it is also much more difficult to accomplish any results with it, partly on account of the evident distrust of the so-called old-time mining captains of anything suggested by a technical graduate, partly on account of the inertia of labor itself, and partly on account of the natural hesitancy of some mine managements to permit anything that may seem a radical departure from ancient and honorable customs. Yet it can be shown by actual tests, supplemented by correct cost figures—by these I mean costs based on observed and recorded facts and not pro-rated costs—that material savings are easily made without departures in any manner radical in underground practice.

In order to arrive at a correct analysis of any set of conditions it is of course important that the observations of these conditions be as accurate as possible. It is also obvious that a long continued set of observations is more nearly correct than a short one.

In the practice of rock-drilling many different methods are employed, many sizes and shapes of drills are used. Some of these drills are better than others; sometimes, perhaps, one only is the best for a certain class of work. Careful study and patient investigation are required to come to any definite conclusion. The selection of the drill depends on a large number of factors, the most apparent of which are:

1. Hardness of the rock to be drilled.
2. Irregularities of the rock, causing the steel to bind in the holes.
3. Diameter of drill cylinder.

*Read at meeting of the Copper Country Club, March 8, 1913.

4. Piston stroke, if any.
5. Weight of moving parts.
6. Effective blow.
7. Total weight of drill.
8. Depth and diameter of holes to be drilled.
9. Style of chuck.
10. Shape of bits.
11. Use of water in holes.
12. Hollow steel with water or air jet.
13. Wages of miners.
14. Cost of power.
15. Various other factors, depending on locality, etc.

Each of the foregoing factors goes to determine in a manner the proper drill to be used. What appears to be the proper drill having been selected, first an investigation of the amount of air it consumes should be made; second, a time study of its operation.

For the first of these studies may be used the graphic air-flow meter which has been perfected by the General Electric Company which measures in cubic feet the air consumed by any device connected to it.

One of these meters was installed at the property with which I am connected. The meter was first used on the 1900 foot level to measure the amount consumed by a R 3 drill and a Butterfly drill No. C110. Only one drill was working on the line at a time. A recording air-gage was also connected to the line, to ascertain the air-pressure near the drill for comparison at any instant with the graphic flow-meter records.

For a fairly accurate time study of the operations of the drill, nothing more is needed than a watch and a note book. Mr. R. T. Dana and Mr. W. L. Saunders in their work on rock-drilling have published a formula which permits of a set of short observations being used for an estimate of drilling performance. The formula is:

Time to drill one hole=(e—fd) D/f—(l—g—k)

in which the quantities signify as in the table following. The table includes also the figures obtained at our mine.

e=average time to change steel	our figure,	4.00	min.
d=average time to drill one foot	our figure,	4.87	min.
l=average time to move drill	our figure,	16.00	min.
g=average time to set up drill	our figure,	12.00	min.
k=average time to blow, blast holes, etc	our figure,	24.00	min.
D=depth of holes in feet	our figure,	8.1	ft.
f=length of feed	our figure,	2	ft.
fd=time to drill length of feed	our figure,	9.6	min.
Number of bits per hole	our figure,	4.0	

Then if 540 is the number of working minutes per day shift, the number of holes per day shift=

540

(e—fd) D/f— (1—g—k)

It may be seen that a slight difference from average values will materially affect the result.

The time record taken from the chart of a single shift—day shift, January 31, 1913—is as follows:

Drill reciprocating	36.5%	
Changing steel	15.4	
Moving drill on post	17.5	
		69.4%
Mucking out for post	10.7%	
Time lost going to face	4.1	
Getting drill steel and water	2.2	
Cleaning and charging holes	2.8	
Blasting	2.9	
Blowing smoke	7.8	
		30.5%
Number of holes per shift	6	
Feet drilled per shift	40.5 (medium hard amygdaloid)	
Cutting speed	0.205 ft. per min.	

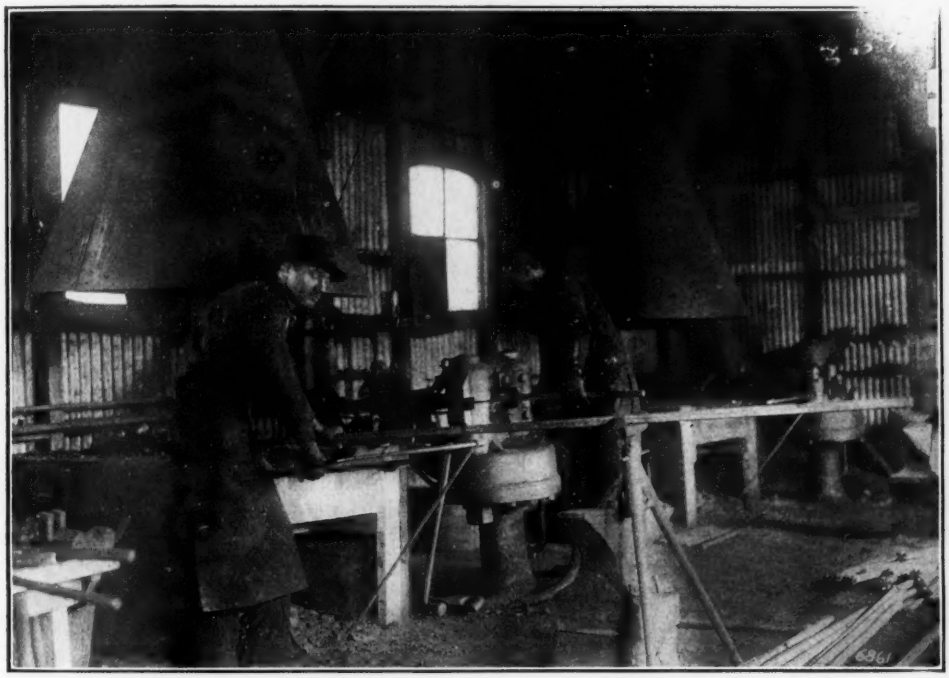
The air pressure was about 96 lb. absolute, the consumption of air around 110 cu. ft.—for the C110 drill 85 cu. ft.

From this time study it appears that the first three factors, amounting to 69.4%, are inherent in the operation of the particular drill and cannot well be reduced. The other factors, amounting to 30.5%, may be reduced for the benefit of the former,—that is, for more actual-drilling time. This may be accomplished by a change in the method of drilling holes or by employing additional labor to perform part of the 30.5% time-loss, always with the condition that the cost of the additional labor is repaid by the increased footage obtained. In our case it is not.

There is always the question of convenient blasting. This is best done at the end of the shift, in order to allow the smoke to clear. Blasting is done when the proper amount of holes are drilled for a cut or a square. Any holes drilled in addition will simply be a loss, unless the ground to be broken is so uniform that the effect of blasting may be estimated with certainty beforehand. The mucking-out time may be saved by having the broken material removed between shifts, or by working the drillmen and muckers on alternate 8-hour shifts. Another simple method is to have one party of miners work two adjacent headings, the muckers clearing out the blasted face, while the drills are working on the other face. In the case under consideration a fan cut is used, whatever is drilled being blasted at the end of each shift. With this method a complete square can be drilled with reasonable certainty of breaking the ground.

It is apparent that a considerable number

of factors must be considered in each individual case to reduce the non-drilling factors. It is also a fact that what may be an economical method in one case may not be found to be applicable indiscriminately everywhere. The working out of these problems is the legitimate and logical field of the efficiency engineer, but he must be given a reasonable amount of authority if his work is to be profitable and possible.



LEYNER SHARPENERS ON THE NEW YORK SUBWAY

S. W. SYMONS.

Though the power sharpener has been used for some years in the big mining districts, and in fact is now considered to be almost indispensable, it is only recently that the general contractor engaged in work of a temporary character has considered its use at all. This is rather surprising in view of the immense economies which can be realized by a properly proportioned and efficient underground installation even when it is not to be permanent. Just such a plant is installed at 131st St. and Park Ave., New York, where McMullan, Snare & Triest are at work on a large section of the new Lexington Ave. subway. The plant is located in a vacant lot and consists of two Leyner Power sharpeners, an air operated steam hammer and three forges in one building and beyond it a small machine shop for which power is supplied by a steam engine operated by compressed air. The air is supplied by Rand Steam Driven Compressors, which also serve to operate the Rock Drills. The air, before being used passes through a reheater, simple but efficient, consisting of a coil of pipe laid on the ground with a slow burning coke fire inside. The coil is closely packed so as to give a large heating surface and at the same time to control the draft.

One sharpener, of the Leyner type, is used for sharpening steel for the large rock drills which use the standard cross bits, and the other is equipped for sharpening steel for the "Bull Moose" self-rotating Jap drill, of which a great many are being used on this work. The type of sharpener used has proved extremely satisfactory, being both cheap in first cost, easy of installation and in operation rapid and efficient.

It is hardly necessary to describe the sharp-

ener, since the makers issue a bulletin giving detailed description of the working and operation. In this particular installation the operator turns out completed bits from the blank on 1" hollow hexagon steel (for the Bull Moose Drills) at the rate of 60 per hour steadily. Cross bits for the larger drills are turned out almost as fast, and the re-sharpening of steel that has been dulled through use is accomplished a little faster.

The finished steel is stored in racks outside the smith shop and taken to the work as needed on a light wagon which also carries back the dull steels for resharpening. This high average of sixty bits to the hour shows the great economy that can be realized by the use of a power sharpener, besides which the bit turned out is of a far superior character to the hand sharpened bit, the system of forcing the steel into a die and forming the bit to an exact and standard shape with a dolly giving a finished drill bit which will obviously be the most efficient for the class of work on which it is to be used. In this sharpener the steel is held in an air operated vise or clamp, exerting a pressure of several tons, and the red hot metal is forced back into the dies by the dolly, operated by rapid blows from a hammer exactly the same as a riveting hammer. This means that the bit end of the steel is forged to shape and the particles compacted into a limited space while the length of steel is held on a rest absolutely without strain, thus obviating the tendency to crystalize so often experienced with sharpeners where a backing block is used to hold the steel in place.

After the bit has been formed, the grooves to allow the passage of the rock cuttings are made with formers placed in the main vise or clamp which is raised and lowered somewhat like a steam hammer while the steel is turned to present the proper surface. All this is accomplished for any one size and style of bit on any standard cross section of steel without changing a single part of the equipment and by the use of but one lever. When a new style of bit is to be made, or the same bit on another cross section of steel, it is necessary to change the dies and dollies as the case may be, this change taking but a few minutes.

As will be seen from the above notes the McMullan, Snare & Triest Co. have surely demonstrated the economy and practicability of the power sharpener for contract work.

AIR NITROGEN FERTILIZERS

Cyanamid is made by absorbing pure nitrogen in calcium carbide at a very high temperature. Calcium carbide, as is generally known, is the material commonly used to generate acetylene gas. It is made by fusing together lime and coke in an electric furnace. The nitrogen used in making cyanamid is obtained by liquifying air, and allowing pure nitrogen only to evaporate from the liquid air.

Nitrate of Lime is made by blowing air through an electric arc, thereby causing combination between the nitrogen and oxygen of the air. This gaseous product, containing nitrogen oxides, is absorbed in milk of lime, which is then evaporated to dryness.

Hence, in the manufacture of cyanamid, the nitrogen is separated from the oxygen in the air and is fixed in white-hot carbide.

In the manufacture of nitrate of lime, the nitrogen is chemically combined with the oxygen in the air, and these nitrogen oxides are fixed in milk of lime at ordinary temperatures.

Cyanamid is a dry, porous, non-crystalline, dark-colored fertilizer material, which has an immediate but slow and progressive action in the soil.

Nitrate of lime is a granular, crystalline, grayish-white material, which has a quick action in the soil, and is especially adapted agriculturally for top-dressing.

About 25,000 tons of cyanamid is now being made and sold in America per annum. The manufacture of nitrate of lime in this country is still in the experimental stage, and only a few hundred tons have been used for agricultural purposes.

DRILLING IN MID-AIR

BY C. M. HANSEN.*

At the Bullwhacker Copper Company's Mines in Butte, Mont., a great deal of glory-hole mining has to be done which would be extremely difficult, perhaps impossible, with a piston drill. Much of the cutting is done in mid-air in locations that are almost inaccessible, and often where there is no opportunity for a foothold. However, by means of a jack-hamer drill, the miner is able to make good progress with comparatively little difficulty.

A tripod drill would be out of the question for work of this sort and even an ordinary

*Butte, Montana.

TYPICAL STUNT WITH JACKHAMER IN A MONTANA COPPER MINE.

hand hammer drill would be extremely troublesome to operate on account of the difficulty of rotating it in such cramped quarters.

The jackhamer is fitted with an automatic steel-rotating mechanism, so that the miner simply has to apply the tool to the spot to be drilled, open the throttle and the jackhamer does the rest. In many cases the operator works sitting on a wooden seat in a rope sling let down over the side of the cliff, and one of the accompanying illustrations shows the method of drilling a particularly difficult hole where a rope-suspended ladder had to be pressed into service. Here the operator has one foot on the ladder and is braced against it. There was just sufficient footing

for the left foot on a projection of the rock.

One can get an idea of the dangerous nature of work of this sort when it is considered that it is 75 feet from the operator's position to the bottom of the cut, where the ore which is broken is mucked into the cars and hoisted on an incline to the surface. A low grade copper ore, averaging about 4 per cent. copper, is mined at this location, the vein matter averaging about 125 feet in width at the place where the photographs were taken.

Great speed is made in drilling the rock, the jackhamer drilling about 6 feet every six minutes, operating with compressed air. Of course this record is very high, but the rock, an oxidized granite formation, is not hard. Three foot starters are used, followed with the six foot steels, the holes being drilled to take 1¼ inch powder. A simple steel holder attached to the fronthead is found to be a material aid in withdrawing the steel from the hole. In addition, it enables the operator to lower and raise the steel in the hole, churning up the cuttings and preventing the steel from sticking or binding. The jackhamer is fitted with a special hole-cleaning device by means of which the operator can at will send a jet of air through the hollow steel to the bottom of the hole, thus keeping the drill hole clear of cuttings, dirt, etc., without removing the steel.

The writer witnessed an interesting performance of this jackhamer drill recently at the Bullwhacker Mine. Drilling was started about 8 o'clock one morning, using only one machine, and by 10 o'clock about 15 six-foot holes had been put in. After they had shot into this glory-hole it kept the muckers busy until noon of the following day getting the broken rock out of the way.

During the month of April of this year they broke enough ground at the Bullwhacker Mine with one jackhamer drill to enable them to ship sixty-four cars averaging about 50,000 pounds each to various smelters near Butte.

AERATING THE CATSKILL WATER

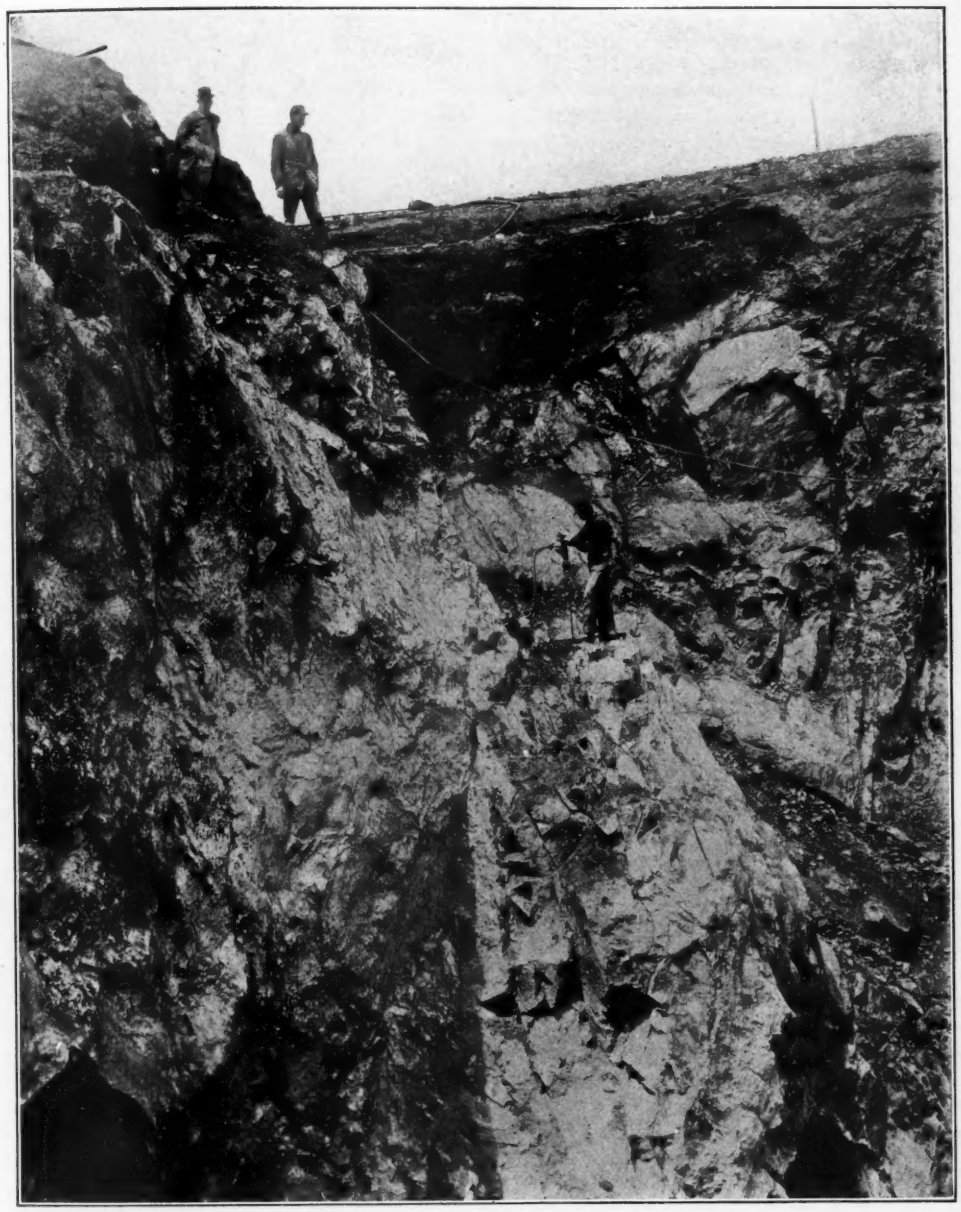
BY J. F. SPRINGER.

At Kensico Reservoir the aqueduct water is to be thoroughly aerated as it leaves for its final passage to the city. Aeration is a very simple matter. It consists essentially in exposing the water when minutely divided to the action of the free oxygen in the atmosphere. The oxygen costs nothing; so that the chief expense is confined to managing and manipulating the water so as to bring about the desired division in the presence of the atmosphere.

The aerating apparatus will be located upon a by-pass connected with the effluent works of the Kensico Reservoir. Essentially, the aerator consists of a large number of nozzles fitted, for the most part, to risers projecting upward from a series of horizontal and mutually parallel pipes to which the water comes under pressure. These nozzles eject the water in such way as to form a fan-shaped jet. There is a distinct whirling movement. It is expected that the jets will rise to a height of about 15 feet. The normal head may be taken at 20 vertical feet. The entire group of jets, about 1,600 in number, will be arranged in a basin of concrete at a point accessible to sightseers. The display should really be worth seeing. While the water is in the jet form it will be exposed to the action of the free oxygen in the atmosphere, and afterwards the oxygenating activity will continue because of the particles of air trapped and carried along.

The practical working out of this system has been the subject of study and experiment. The nozzle which will probably be used is in the form of a cylindrical shell fitted above with a short abruptly tapered tip in the form of a frustrum of a right cone, and below with a flange affording a suitable means of attachment to the risers. The nozzle is 7½ inches in height over all. The internal diameter of the exit opening is 1⅜ inches, the internal base diameter is 3¼ inches, enlarging to 4 inches. There are within three vanes, so formed and arranged as to impart a whirling or rifled movement to the column of water passing through. These vanes extend at the bottom in a radial direction from the shell to about ⅜ inch of the center. They are formed of thin plates and are 4 inches long. They make a quarter turn. Vanes and shell have a common thickness of ⅛ inch. The bolt holes in the ⅜-inch thick flange are arranged on a circle having a diameter of 7½ inches. The material is bronze. They are accordingly quite expensive; but it was necessary to have in view the effects of corrosion on the concrete if a corrodible metal of any kind, such as iron or steel were employed.

It is expected that the 1,600 nozzles will be competent to aerate the entire capacity of the aqueduct when the flow line in the reservoir



A COMFORTABLE JACKHAMER JOB IN A ROUGH SPOT.

is at its normal level. The basin of the aerator will be 460 feet long and have a maximum width of 240 feet. There is to be a concrete apron having a width of 20 or 25 feet which will surround the basin proper. Its function will be to return any water carried beyond the limits of the basin itself. The plan outline of the basin is that of "a rectangle to which semi-circles have been added on the ends and on one long side." Water comes to the aerator through several concrete conduits.—*Cassiers.*

A seam of coal 12 feet thick has been found near Isabel, S. D. It is said to be only six feet from the surface.

DRIVING A TUNNEL WITH MACHINES ON TRIPODS

BY THEODORE V. K. SWIFT.*

A description of the methods used by Witherbee, Sherman & Co., Inc., Mineville, N. Y., in driving an 8x9-ft. haulage tunnel in exceptionally hard rock may be of interest to mining men who have similar work to do.

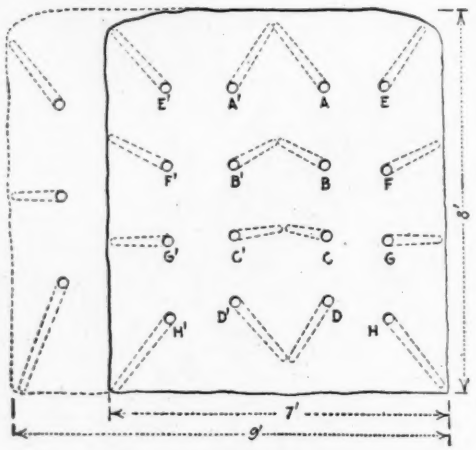
The character of ground drilled is a mixture of unusually hard granitic gneiss with hard magnetite. The granite is very difficult to drill but breaks fairly well, while the magnetite drills more easily but does not break so well. The ore in the tunnel varies from a few inches up to eight or 10 ft. in width but through the last 200 ft. the ratio of granite to magnetite is approximately 3:2. Two 10-hr. shifts are worked with an hour between each shift and an hour for dinner.

FACE DRILLED BY TWO MACHINES ON TRIPODS. A THIRD MACHINE FOLLOWS AND SLABS OFF.

Two Ingersoll-Rand C-100, butterfly-valve, 2¾-in. machines, mounted on tripods of the Rand type, are used to drill the face and are operated by a drill runner and helper for each drill. The face is carried seven feet wide and eight feet high and a third machine is employed to follow up these two heading-machines and bring the tunnel to the proper width of nine feet. This machine is not run steadily. During one month it was capable of doing its work in an average of two shifts per week. This method is found to be quite advantageous over the method of carrying the face to the full width of nine feet as the tunnel advances, for this third or "trimming" machine can put in long side holes and break the ground more efficiently than if the holes are put alongside the other breast holes. This widening by the third machine is done on whichever side of the tunnel has the sharpest curvature, thus tending to ease the curves somewhat, as the tunnel follows the ore.

VERTICAL CUT USED IN THE HEADING.

Sixteen holes are needed to break the 7x8-ft. section. These holes average 4½ ft. in depth. Repeated efforts with deeper holes showed it to be impossible to break them to their full depth. The round is drilled approximately as indicated in the accompanying drawing, the dotted lines showing the work done by the



LAYOUT OF HOLES.

trimming machine, whose 8- or 10-ft. holes it is easy to bring because of the free side-face to break to. Much difficulty is experienced in drilling this hard rock and it often requires two or three starters and generally more than one second drill on each hard "upper." This round is drilled and fired once every 10-hr. shift and although the footage per drill may seem low, it is, nevertheless, a good shift's work, considering the unusual nature of the ground. Tripods are used simply because the nature of the work in other parts of the mine is not suitable for a column or bar and neither of these rigs is included in the mine equipment. One setup is generally sufficient to allow each machineman to drill his half of the round. A hitch is cut in the floor with a piece of hand steel for the point of the forward leg to rest in, a wooden block is buried in the muck as a foundation for the hind leg and the third or outside leg is thrown up against the side wall and does not rest in any hitch, thus leaving the whole rig free to be moved out of line, if necessary, when changing steel. Eight cut holes for the vertical cut are drilled and are bottomed as nearly as possible in pairs, *A* with *A'*, *B* with *B'*, etc. Outside of these, eight side holes are drilled to break even with the bottoms of the cut holes. Each machine is started on the top holes and lowered as the holes are drilled, one setup being sufficient for each machine with the necessary swinging of the machines in the saddles and adjustments of tripod legs. An air pressure of 60 to 70 lb. is maintained at the face.

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*Mine captain, Witherbee, Sherman & Co., Inc., Mineville, N. Y.

FUSE BLASTING WITH DYNAMITE OF TWO STRENGTHS.

Du Pont 60% Repauno gelatin dynamite is used in all cut holes and du Pont 45% Repauno gelatin dynamite is used in side holes which are not too heavy, all sticks being spit and thoroughly tamped as they are put in the hole. All holes are fired with du Pont No. 6 blasting caps and du Pont double tape white fuse. In all cases the primer is put in the hole next to the last, with one stick on top of it, and all holes are thoroughly tamped with fine wet ore in standard du Pont paper bags. Holes *A A'*, *B B'* and *C C'* are spit first and as nearly simultaneously as possible. *E E'*, *F F'* and *G G'* with fuses cut four inches longer are spit next and the lifters *D D'* and *H H'* with fuses four inches longer than the side holes are spit last in order to throw the muck back as far as possible from the face. It requires two men to light these holes properly. All powder is prepared and all holes are loaded and spit by the regular mine powder-monkey with the help of one of the machinemen.

MUCKING COMPLETED IN ONE-HALF OF EACH SHIFT.

All mucking, tramming and track laying is done by three muckers who work half a shift only and are then moved to some other part of the mine. At the beginning of each shift these men are sent directly to the face and muck back sufficiently for the machines to be set up while the machinemen are assembling their rigs, connecting hose, etc. Permanent 45-lb. rails in 30-ft. lengths are laid on 4-in. ties as the tunnel advances. Two sets of 15-ft. 45-lb. rails and one set of 5-ft. 45-lb. rails are used temporarily to keep the track as close to the face as possible. Koppel 2½-ton, 22-cu. ft. capacity cars are used and are trammed to a side track where an electric locomotive hauls them to the portal of the tunnel. Short-handled shovels and no muck-plates are used.

Detailed costs for the month of October, 1912, are given in the table. This is not phenomenally cheap or rapid driving but under the unusually disadvantageous conditions, especially the hard formations, it was considered satisfactory.

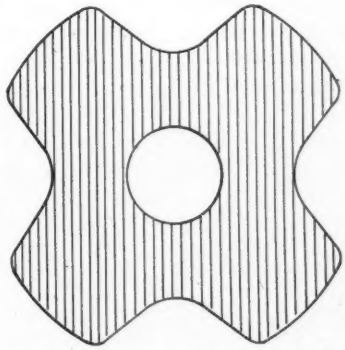
FORGING AND TEMPERING DRILL STEEL

The heat treatment of drill steel, hollow or solid, but particularly the hollow steel, is a special art. Only extended experience and careful attention to details will enable a blacksmith otherwise most capable to get the best results from steel of this type.

Properly treated, however, the life of hollow drill steel can be extended to extraordinary lengths, and breakages can be rendered almost negligible in the long run. It goes without saying that all steel must eventually break in the hard work of hammer drilling, but the careful blacksmith in co-operation with the watchful operator can get wonderful results where a fine quality of steel is used. Not every blacksmith or operator realizes this, and few have the time or the patience to experiment for the purpose of acquainting themselves with the individual properties of the special steels which may be in use at the mine.

As a help and a guide to blacksmiths handling drill steel, the International High Speed Steel Company has issued a special letter of instructions for the treatment of the "Bulldog Special" hollow and solid drill steel which this company manufactures.

The steel is made in Sweden, from the purest Swedish ores, and the instructions, which are reproduced below, come direct from the mill at Sandviken, Sweden, where elaborate experiments have been conducted to determine exactly at what temperatures and under what conditions of handling the best results can be obtained with "Bulldog Special" steel.



SECTION OF STANDARD CRUCIFORM STEEL.

The cut is a section of standard cruciform steel of this make, concerning which the following particulars are given out:

DETAILS OF STANDARD CRUCIFORM STEEL.

Outside Diameter in.	Diameter of Hole in.	Wt. per foot Solid lb.	Wt. per foot Hollow lb.
¾	¼	1.34	1.01
⅞	¼	1.60	1.26
1	5/16	2.17	1.76
1⅛	5/16	2.73	2.22
1¼	⅜	3.35	2.83
1⅜	7/16	3.98	3.69
1½	7/16	4.70	4.51
1¾	½	6.82	5.89
2	½	9.10	8.03

FOR THE TREATMENT OF "BULLDOG SPECIAL" DRILL STEEL.

Forging. The heating must be done very carefully. If the steel is heated too highly it will become coarse grained and brittle, and cannot be restored. The steel should not be heated to more than a *light yellow,* and at this heat it must be taken out of the fire and worked at once. This applies particularly to tools in which a considerable change in shape from that of the original bar is required, and at this heat the steel can be worked thoroughly. Where there is not much forging to be done less heat should be used. But it must be observed always that hammering must be continued until the steel takes on *a dull red or brown color,* so that the grain will be coarse and firm.

Hardening. The steel should be heated slowly and evenly, and only that part which is to be hardened should be heated, and then only to a *dull red.*

Harden in water at a temperature of 75 to 85 degrees Fahr. The cutting edge of the steel should be submerged to a depth of only about ¾ inch. The neck of the tool should be submerged to a depth of 1¼ inch. But where the neck is upset, the steel should be hardened to a point about an inch below the upset part. When the tool is thoroughly hardened it should be taken out of the water and rapidly cleaned and tempered.

Tempering. It is impossible to give absolute rules for tempering the cutting edge of a drill steel. Broadly speaking, the temper must be suited to the hardness of the rock, and a careful study of the power of resistance of the steel in working will soon indicate what temper is most desirable. Bulldog Special will generally give the best results if tempered to a *dark yellow,* but this must not be taken as a definite rule.

After tempering the tool should be placed cutting edge or point down in a vessel holding a depth of from ¼ to ½ in. of water, and the steel should be left there until entirely cooled.

Tempering the neck or collar. The neck or collar must be tempered—or drawn—considerably more than the cutting edge. The very end or tip of the steel should be the hardest, and the rest should be tempered down gradually until it runs into the unhardened body of the tool. The tip or hammer end should be hardened to a light gray, or, if possible, until the steel only shines in a perfectly dark room with a dull brown color.

The cooling may be done in water, as with the cutting edge, but in treating Bulldog Special it will be found that the best results are obtained by allowing the steel to cool off in the natural air. When the neck or collar is cooled off in water the utmost caution must be used, and the cooling must be done very slowly. If at all permissible let it cool off in the air at ordinary temperature.

These instructions are being circulated gratis by the International High Speed Steel Company in such form that they can be readily hung on the wall of the blacksmith shop, or wherever most easily accessible.

"SOME NOVEL USES OF COMPRESSED AIR"

An extensive and liberally illustrated article with the above title in a recent issue of the *Scientific American* enumerates a number of things none of which have really any novelty at the present time, at least to readers of COMPRESSED AIR MAGAZINE, but it is still well to call attention to them occasionally. The pneumatic hammer is given the first place as used for chipping, riveting, caulking, etc., and for the wide variety of work normally employing a hammer or sledge or a dead weight raised and dropped continuously, as in sand ramming in the foundry and in paving work. Then there is the rotating pneumatic drill or auger for metal and wood work. Bell ringers, sheep shearers, butcher's cleavers and cane cutters are spoken of, and last and most novel of all is the compressed air auto starter, gear shifter, etc.

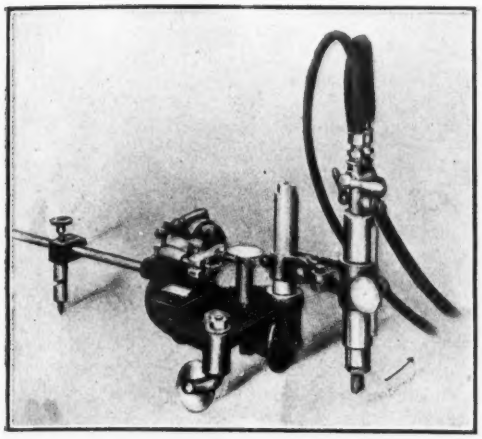


FIG. 1.

MECHANICALLY-GUIDED METAL-CUTTING TORCHES

A recent addition to the line of apparatus developed by the Davis- Bournonville Co., 30 Church St., New York City, for mechanically guiding cutting apparatus, is shown in Figs. 1 and 2 of the accompanying illustrations. This new machine is known as the "radiagraph." It is a motor-driven device especially adapted to straight or circular cutting. The construction is very simple, the principal parts of the machine being a three-wheeled carriage for supporting the cutting torch, which is propelled along the surface of the work at the most efficient rate of speed by a small motor.

As will be seen by referring to Fig. 1, this motor connects with a vertical shaft through worm-gearing. At the lower end of this vertical shaft, there is a second set of worm-gearing which transmits motion to a horizontal shaft, which, in turn, drives the front tractor wheels through spur gearing. When it is desired to cut a circular opening, the conical center seen to the left is turned down into engagement with the surface of the work, which lifts the carriage slightly so that the weight is supported by the two outer wheels. The motor is started and the carriage then moves in a circle about the central pivot, and an opening is cut by the torch, the diameter of which depends, of course, upon the distance from the torch tip to the central pivot. The machine has a capacity for holes six inches in diameter and upwards. The driving motor is equipped with a small friction brake for regulating the speed in accordance with the thickness of the metal being cut. The rate of speed is shown by an indicator, not in place in this particular view.

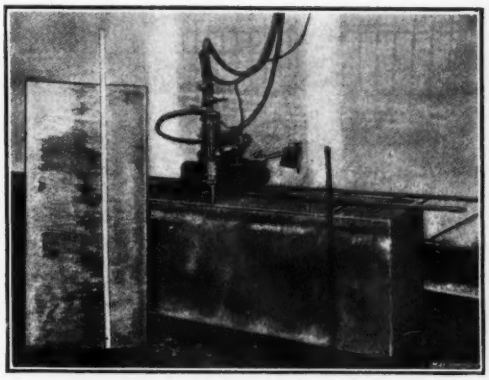


FIG. 2.

Fig. 2 shows the application of the radiagraph to straight cutting, the work in this instance being a piece of armor plate 16 inches thick. The machine is caused to move in a straight line by mounting it upon parallel tracks having V-shaped grooves for the wheels. This track is notched at the ends so that two sections can be joined readily. For ordinary work one section is sufficient, but when taking long cuts, two sections are employed, thus making it possible to prolong the cut indefinitely by placing the rear section to the front as soon as the machine has passed it. The rate of traverse for cutting 16-inch armor plate is about four inches per minute and, as the illustration shows, the kerf left by the flame is remarkably smooth, considering the depth of the cut. For this particular work, the oxygen pressure was 125 pounds per

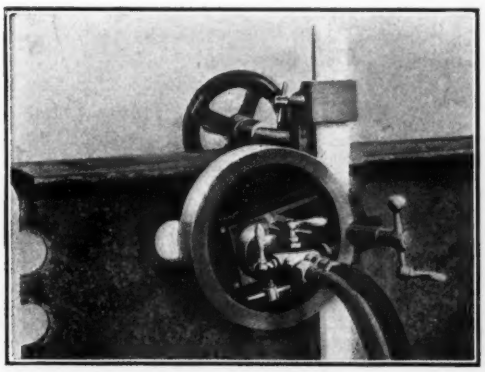


FIG. 3.

square inch. In case it is not convenient to connect the motor with a lighting circuit, small batteries can be used, so that the machine is adapted for yard use as well as in the factory.

Another recent development of the Davis-Bournonville Co. is shown in Fig. 3. This machine is known as a holograph and it was designed for cutting holes in the webs of rails or in structural material not more than ¾ inch thick. This machine has a circular member for holding the torch, which is rotated through bevel gearing by the handle seen to the right, thus causing the torch tip to move in a circle. The web of a rail can be pierced without any previous drilling and the machine will cut smooth round holes varying from ½ to 2 inches in diameter, in from 30 to 60 seconds. The diameter of the hole cut, is varied by simply shifting the torch holder to or from the center of the rotating disk. The torch rotating mechanism is held in position by a vertical bar which, in turn, is clamped to the rail by the screw or handle shown. The holograph is especially adapted for railroad work and for enlarging or cutting holes in structural steel. —*Machinery.*

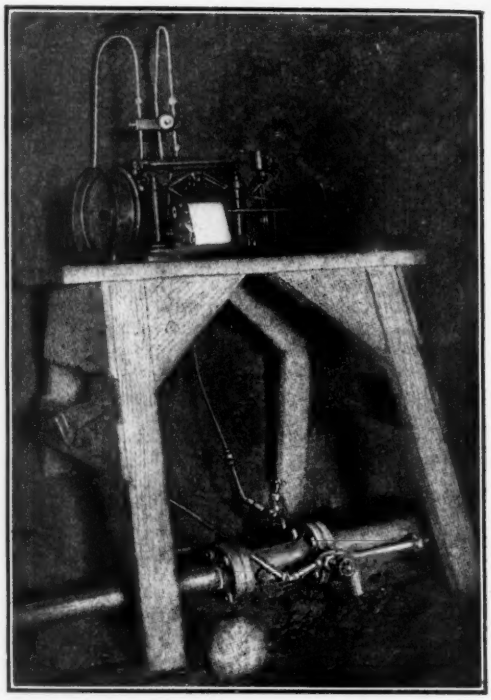


FIG. I.

MEASURING AIR CONSUMPTION.

BY ANDRE FROMIS.*

Since the introduction of compressed air in mining operations, many attempts have been made to produce a satisfactory means of measuring the actual air consumed by any given appliance. It is generally known that the builders of air machinery use a displacement tank to measure the air. This may solve the problem in the laboratory or the shop, but owing to the nature of the cumbersome equipment, such a device cannot well be moved from place to place, let alone to some restricted underground opening. Nor does the displacement tank register automatically a continuous line graph, depending for its position on time values and cubic feet as coordinates. Such a graph is unquestionably of greater value than the mere knowledge of actual air consumed. It permits of a time study that may point the way toward effecting material savings.

Present-day engineering efforts tend to analyze in detail all the processes in the production of tonnage. The most important factor is the time-labor element. If then a certain appliance, such as a rock drill using compressed air shows a high time-efficiency, as compared to one showing low efficiency, it can be seen that even a considerable increase in air consumption will be largely outweighed by the additional work done with the high time-efficiency machine, always provided that the two machines have similar drilling characteristics.

This is well illustrated by comparing the old style, heavy, 3⅛-in. piston drill (quite indispensable in certain hard formations) and the jackhamer drill. The latter may actually drill at a lower speed, but a material gain is made by the absence of time loss in rigging up a post and in taking down and moving the drill on the post for new holes. One man operates the jackhamer drill, compensating for a smaller footage drilled.

In order to obtain satisfactory time-study values underground heretofore, sole dependence was had on observations made by an individual with watch and notebook. There

*Superintendent Ojibway Mining Company, Ojibway, Mich.

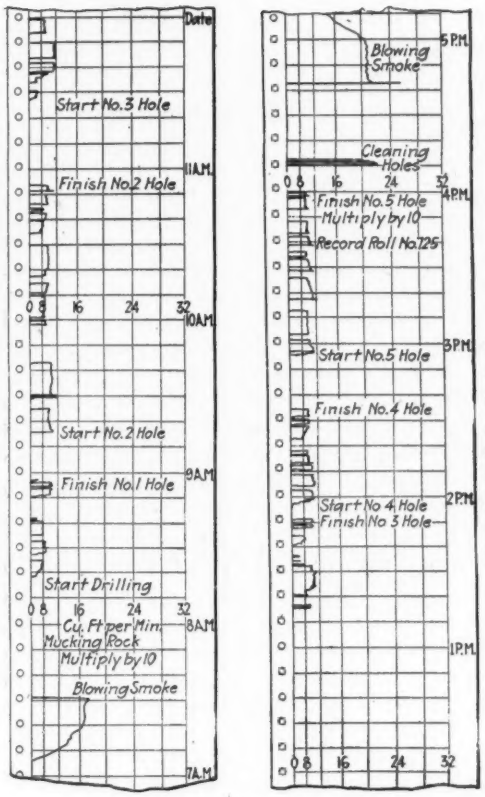


FIG. 2.

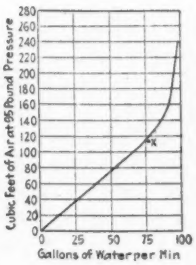


FIG. 3.

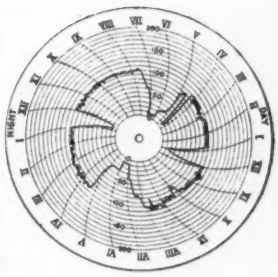


FIG. 4.

was always the question of quality and personal judgment, and futhermore the men operating the drill felt that they were under observation and the records thus made can hardly be classed as average performance.

AIR RECORDING METER NOW ON THE MARKET.

The General Electric Co. has lately put on the market an airflow meter, which measures the cubic feet of air consumed and records it graphically on a moving strip of paper. It can be seen that an observer's notes are accurately checked by such a meter, which is tireless and will run for a whole week without attention. A continuous record over a week of day-and night-shifts forms a basis for calculating a fair average shift's performance. One of these meters was installed at the property with which I am connected, and various air-consuming devices were measured. The most important were air drills, and time-studies were made in connection with these.

Fig. 1 shows a view of the meter with cover removed, connected to the air main on the 1900-ft. level, No. 2 shaft. One drill only was operating on this line on two 9-hr. shifts. A recording air-gage was also installed to ascertain the exact air pressure at any time near the drill. Fig. 2 is a copy of the record of the day shift Jan. 29, 1913, illustrating the cycle of work from one blasting to the next. The corresponding record of air pressure is shown in Fig. 4. The time study made in connection with the graph, Table I, illustrates the

TABLE I.

	b Day Shift, Jan. 29		*c* Average of Seven Consecutive Shifts
	Total Time Consumed Minutes	Percentage of Total Time Consumption	Percentage of Total Time Consumption
Drill reciprocating	197	36.5	34.9
Changing steel	83	15.4	12.6
Shifting machine	95	17.5	*a* 13.9
Mucking for setup	58	10.7	16.4
Starting work morning and noon	22	4.1	5.7
Getting steel and water	12	2.2	3.2
Cleaning and charging	15	2.8	3.7
Blasting and tearing down	16	2.9	4.3
Blowing smoke	42	7.8	5.4

a 61.4% unavoidable.

b 40 ft. 5 in. of medium hard Kearsarge amygdaloid drilled with one 3½-in. piston machine. Cutting speed 0.205 ft. per min. Irregular rock bound steel. Flat holes in 7x10-ft. drift. Air pressure, 95 lb.

c. Average number of holes drilled, 6. Average footage, 42.3.

progress of the work. It will be seen that the time-consumption items may be divided into avoidable and unadvoidable, the latter inherent in the operation. Such are the time that the drill is reciprocating, the time consumed in changing steel and that consumed in shifting the machine on the drill post. The remaining factors may be reduced or perhaps avoided if the additional footage drilled will pay for the additional labor required to do this work. Table II gives a distribution of the costs for the shift in question.

TABLE II.

	Amount per Shift	Cost per Foot Drilled
2 miners @ $2.87	$5.74	$0.1420
Blacksmith @ $2.75 and helper @ $2.00	0.47	0.0116
Air, including labor, oils, etc., @ $108.79 per month	2.08	0.0518
Drill repairs @ $0.40 per shift	0.40	0.0099
Total	$8.69	$0.2153

DIFFICULTIES ENCOUNTERED WITH MINERS.

In stoping, conditions are somewhat different and more actual drill-reciprocating time should be obtained, but this may be pushed too far and it will be found that holes are drilled in excess of those required to break the tonnage. A larger amount of explosive will also be used. If in this case the men are reproved or fined for drilling what may appear to be excess holes, especially if this footage forms a contract basis, there is always the question of judgment and for harmony's sake a board of arbitration may be advisable. There may also result some dissatisfaction among the men, making it hard to obtain good labor; finally the men may be led to neglect the trimming of the hanging wall, thus endangering the trammers on the levels.

It is thus apparent that a number of points must be considered at all times in order to equitably reduce the time-labor factor underground. It is also a fact that what may produce economical work in one property cannot be applied indiscriminately everywhere.

The study of these conditions is the logical field for the efficiency engineer, but he must be reasonably free from interference and be given enough authority to make his work possible and profitable.

The air meter was also used to investigate the air consumption of a small, single-stroke 7x3½x7-in. plunger pump. The water was pumped a height of 250 ft. on an angle of 33°, the size of the suction and discharge lines being according to the manufacturers' specifications. The strokes per minute were counted and noted on the chart at the corresponding air-flow line. It was found that at 130 strokes, 85 cu. ft. were used. The horsepower drawn from the boilers to compress this amount of air was 13.1 hp., according to the manufacturer's catalog. The theoretical power required to pump the amount of water is 2.56 hp., without friction or leakage losses. The electrical power required, to pump this amount would be conservatively four boiler horsepower.

Fig. 3 has been plotted from a set of observations. It shows that the most economical speed is about 75 gal. per min., corresponding to the point marked *X*. This happens to be about three times the water to be handled per day; thus it determines the size of the sump, and the number of attendants required to run a given number of pumps. Of course, the economical point is determined by such considerations as leakage in air valve, slippage in water end and water valves, moisture in compressed air inducing freezing, and size of suction and discharge pipes. This confirms the well known fact that pumping by air is uneconomical. At times electric pumping would entail considerable expense, but for permanent installations any reasonable additional cost will be repaid in a short time.

It may be stated that the air meter can be used on mains from 2 in. to almost any size. It is only necessary to install the nozzle plugs in the mains; the meter can be carried to that point, proper connections made with the nozzle-plug pipes, and a record roll of proper capacity placed on the meter drums.—*Engineering and Mining Journal.*

AIR INSTEAD OF STEAM FOR FIRE ALARM

At Haverhill, Mass., a powerful steam whistle has been in use as a general fire alarm for many years. It has, of course, been necessary to maintain the steam pressure at all times and the corporation has paid a manufacturing concern $300 a year for the service. In place of this an air whistle is now being installed with an electric driven compressor. An air receiver is, of course, provided, which is kept charged up to the required pressure, and the starting of the whistle also starts the compressor so that the blowing may be maintained continuously as long as may be required and no power will be called for except while the whistle is actually blowing.

A HORRIBLE COMPRESSED AIR "ACCIDENT"

There are some dangers so obvious that it would seem to be absurd to warn people concerning them; and yet we are frequently reminded that "boys will be boys" without limit to the possibilities of their stupidity. In a factory at Camden, N. J., recently a "boy" 18 years old put a compressed air nozzle into his mouth and another "boy" turned on the air. The body was distended, the intestines were ruptured and death preceded by intense agony resulted in a few minutes. What can one say in a case like this to enforce the lesson it teaches?

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EVERYTHING PNEUMATIC

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ROCK DRILL EFFICIENCY RECORDS

On another page we print some account of the system followed by the New Jersey Zinc Company for securing by trial and inspection the most efficient and reliable drills for its service. It is proper to remark that the practice described is by no means exceptional with this company, but is practiced in fact by most of the larger concerns. The system in fact reaches much farther than to the selection of drills of the most efficient types, embracing also the maintenance of the efficiency of drills in use and the determining of the times when they must be completely overhauled or repaired, or perhaps more generally thrown out for good. The life of a rock drill which is crowded as it should be is not a long one at best, but while it lives the idea is to have a complete record of it based upon actual, systematic, periodic trial and examination, and the final abandonment of any drill is not based upon the judgment or caprice of any one but upon its proved and actual percentage of all around efficiency based upon the work it can do and the air it consumes in doing it. The practice indicated may not be paraded before the world as scientific management, but it represents business common sense, which is likely to hold its own for some time to come.

COMPRESSED AIR OPERATING CONDITIONS

In a paper read before the Liverpool Engineering Society, Mr. George J. Gibbs pointed out the importance of several conditions which govern the efficiency of equipments operated by compressed air. The air compressors should be supplied with cool, clean air which is as dry as possible. After compression, the heated air should be cooled before it is passed into the mains. Where this precaution is not taken, cooling in the mains will result in a deposit of water of condensation which will gradually collect and be driven forward with grit and rust until it finally causes trouble in the working parts of the apparatus. Compressed air can be conveyed through pipes for considerable distances with practically no loss, especially where the demand is intermittent and where a supplementary air reservoir is placed near the opposite end of the mains from the compressor. Although these are points which are generally mentioned, and which are constantly insisted

upon in COMPRESSED AIR MAGAZINE, their importance warrants the keeping of them before the users of compressed air equipment. In addition to the points above mentioned, two-stage compression is very important for delivery pressures above 40 to 50 lb. The common working pressure for a great variety of air operated tools and apparatus is now from 80 to 100 lb., with a constant tending toward the higher of these pressures.

AFTERCOOLERS AND SEPARATORS

The following from *Power*, July 1, will explain itself:

The note of E. R. Pearce on "Air-Receiver Explosions," in the Apr. 29 issue, in which he suggests that the air should pass through oil separators, represents good practice, as far as it goes. I would advocate the use of an aftercooler for the air to pass through first, and then a separator. Both of these devices may be said to cost nothing to operate, unless the small quantity of water passed through the aftercooler is to be charged. The installation cost may be regarded as a paying investment in practically every case. The aftercooler will somewhat reduce the volume of the air to be conveyed through the piping, and it will condense the surplus moisture in the air, so that it can be abstracted by the separator, as well as the oil. It will also keep the temperature of the air so low that spontaneous ignition in the receiver and piping will be practically impossible. Both aftercooler and separator are requisite for either of them to completely accomplish its work. The aftercooler will condense the moisture, but will not abstract much of it, and the separator will not abstract the moisture until it has been released by the cooling of the air. The functions of aftercooling and separating might be combined in a single device, but it does not seem to have been done.

It may be worth while to note that the too familiar air receiver and air pipe ignitions and explosions are impossible when the air is compressed by the Taylor hydraulic compressor, by the Humphrey pump, or a centrifugal or turbo-compressor, because none of these put any oil into the air. For ordinary working pressures, if two-stage compression is employed, with an aftercooler and separator, these precautions may be considered to guarantee immunity. With a rapidly working single-stage compressor delivering the air at the same pressure, without aftercooler or separator, and with an engineer dispensing oil liberally, the guarantee would be reversed, and it would only be a question of time as to when something would happen.

FRANK RICHARDS.

NEW BOOKS

The Modern Gasoline Automobile, its Design, Construction, Maintenance and Repair, by Victor W. Page, New York, Norman W. Henley Publishing Company. 693 pages 5¼ by 8½ inches, 500 specially made detailed illustrations and diagrams, $2.50.

A complete, practical and up-to-date book, written in simple language, and, although so bulky, with few if any wasted words. The pneumatic interest which warrants our notice of the book is fully catered to in descriptions and discussions of tires, starters, etc.

Handbook of Natural Gas by Henry P. Westcott. Published by Metric Metal Works, Erie, Pa. XIV+529 pages, 4½x7½ inches. Price

In this book there is a table of pipe capacities which occupies 178 pages. There is another hundred pages of other tables and over fifty pages are occupied by illustrations. In the less than 200 pages of actual text there is assembled various information relating to natural gas, gas wells, gas transmission, easily accessible to one in touch with the industry.

The Catskill Water Supply of New York City. By Lazarus White, New York, John Wiley & Sons. 750 pages 6x9 in. Numerous illustrations. $6.00.

This is the work of an able writer, a division engineer of the Board of Water Supply, who had free access to all records and data, and in the preparation of the work he had the assistance of many of his colleagues. It has all the reliability and completeness of an official report without its prolixity. The history of the work is given and accounts of the investigations which determined the location of the route in detail, and the local borings and other preliminary work upon which the contracts were based. The chapter headings suggest the scope of the work, and each chapter is concise and complete in itself. These are:

History of New York Water Works; The Board of Water Supply; Location of Catskill Aqueduct; Borings and Subsurface Investigations; Explorations for Hudson River Crossing; The Ashokan Dams and Reservoirs; Esopus Cut-and-Cover and Peak Tunnel; Rondout Pressure Tunnel and North Half Bontican Grade Tunnel; Wallkill Pressure Tunnel, North Cut-and-Cover, and One-half Bontican Tunnel; Wallkill Valley Cut-and-Cover Aqueduct; Moodna, Hudson, Breakneck, and Bull Hill Tunnels of the Hudson River Division; Peekskill Division Cut-and-Cover and Grade Tunnels; Steel Pipe Lines; Croton Division Cut-and-Cover Aqueduct and Grade Tunnels.

TESTING ROCK DRILLS

The New Jersey Zinc Company, at its Franklin Furnace mine, pays unusual attention to the efficiency of the drills employed. A series of tests begun by the company six or seven years ago, and still in progress, has resulted in greatly increasing the efficiency of the company's drilling and in bringing out some curious points in the performance of rock drills, intelligible in some cases, and in others largely inexplicable.

Every machine under consideration by the company is taken underground and its air consumption and drilling rate are measured, this being done in a certain crosscut where the rock is uniform. The number of perforations in the rock here bears eloquent testimony to the extent of these tests. The holes are drilled for the most part vertically in calcite, since here, as elsewhere, experience is relegating the piston machine to a secondary position. The rate of drilling is naturally high and the absolute figures would not be instructive to a hard-rock miner. The comparative figures, however, among different makes and types of machines, would prove most instructive if the company were willing to publish them.

The air pressure used is between 95 and 100 lb., and remains fairly constant for any one test. The temperature also is constant. The criterion on which the comparison of machines is made is a figure derived by dividing the number of inches drilled per minute by the air consumption per inch, thus taking into consideration both the speed and the air consumption. No machine is accepted for further trial unless it drills at least 7½ in. per min. on 60 cu.ft. of free air or less. A side light on the progress of drill design and manufacture is shown by the fact that for the machines of one manufacturer, the criterion mentioned has increased in some five years from about 0.2 to about 1.5, a remarkable difference.

This test is, so to speak, only an elimination trial. The results are comparable to an engine indicator-card, taken to determine mechanical efficiency. The important factors of convenience, repair expense, retention of original efficiency under wear, steel breakage, etc., are determined by further tests in the harder formation of the stopes. If a drill is purchased, its probation is not yet over. All machines in use are numbered and a careful record is kept of their performance during their whole life. They are, in effect, on the mine payroll, the number of shifts they work is credited to them and the repairs are charged. It would appear that after a few years of this, the New Jersey Zinc Co. should know something about machine drills.

One anomaly developed in the tests, is the fact that a machine will often drill along as well or better with one wing of the cross bit broken off. More curious still are the contradictory results obtained with the same machine under apparently identical conditions. Thus a hole may be collared and a test run made; then, with no further change than a new piece of steel, a second run continuing the same hole may give a rate of drilling much higher. The calcite is too uniform to permit explaining this by a change in the rock quality. Mr. Catlin, however, suggests a very plausible theory. He conceives the blow of the hammer and anvil block on the steel to be transmitted through the latter as a wave. Such a wave will be reflected when the bit transmits it to the rock in the hole bottom and in its return may oppose or may coincide with the next blow of the hammer. When conditions are such that these rebounds reinforce the successive hammer blows, the maximum drilling effect is attained. If the rebound and new blow oppose each other exactly, then the drilling power is appreciably cut down. The usual conditions will be a varying degree of interference, giving varying results. An attempt to analyze and con-

trol the phenomenon, however, disclosed that too many variables existed, of which the chief are the length of the steel and its resiliency. That great variations of resiliency obtain, is shown by dropping the same steel ball on different pieces of steel and noting the number and height of the rebounds. The differences developed are extensive. Evidently in the field of rock drills, drill steel, rock and their inter-relations, there are more things than our philosophers have yet dreamed of.—From editorial in *Eng. and Min. Journal.*

COMPARATIVE STRENGTHS OF BLASTING EXPLOSIVES

The U. S. Bureau of Mines has made elaborate tests of mining explosives in common use to determine the potential energy, the disruptive effect and the propulsive effect, some of the results of the investigations appearing in Bulletin 48. The tabulated results are given herewith, together with the approximate composition of typical examples of the various explosives. The percentages figured are rated against the effect of 40% straight nitroglycerin dynamite taken at 100 per cent.

The figures are fairly consistent with general practice, and it is believed that the classification will serve as a useful guide for comparing the practical value of explosives. It is worthy of note that the potential energy of 40% strength ammonia dynamite and of 40% strength gelatin dynamite, that is, the theoretical maximum work that these explosives can accomplish, is higher than that of 40% straight nitroglycerin dynamite, but that the disruptive and propulsive effects, which represent the useful work done as shown by actual tests, are less. Accordingly, straight nitroglycerin dynamite is more economical for general use in blasting operations if the conditions and character of the work are such as to permit its use; nevertheless, the ammonia dynamite and the gelatin dynamite are more efficient and economical for certain kinds of work that require explosives having a large propulsive effect and a comparatively small disruptive effect. For example, in blasting soft rock, 40% straight nitroglycerin dynamite, which has a very high percussive force, may be too quick in action, whereas the ammonia dynamite or the gelatin dynamite, having practically the same heaving and

TYPICAL ANALYSES AND STRENGTHS OF COMMON BLASTING EXPLOSIVES

	Percentage Composition										Percentage Strength		
	Nitro-glycerin	Combustible Material	$NaNO_3$	ZnO $CaCO_3$ $MgCO_3$	Nitro-substitution Compounds	NH_4NO_3	Nitro-cellulose	S	C	Potential Energy	Disruptive Effect	Propulsive Effect
Straight nitroglycerin dynamite, 30%	30	*a*17	52	1	...	...	...	...	...	93.1	84.1	96.8
Straight nitroglycerin dynamite, 40%	40	*b*15	44	1	...	...	...	...	...	100.0	100.0	100.0
Straight nitroglycerin dynamite, 50%	50	*b*14	35	1	...	...	...	...	...	111.0	109.2	107.4
Straight nitroglycerin dynamite, 60%	60	*b*16	23	1	...	...	...	...	...	104.0	119.8	114.9
Low-freezing dynamite, 40%	30	*b*15	44	1	10	...	...	...	...	...	...	...
Low-freezing dynamite, 60%	45	*b*16	23	1	15	...	...	...	...	60.2	93.5	91.2
Ammonia dynamite, 40%	22	*a*15	42	1	...	20	...	...	...	101.8	67.9	99.1
Gelatin dynamite, 40%	33	*a*13	52	1	...	...	1	...	...	105.7	78.4	95.8
Granulated nitroglycerin powder, 5%	5	*c*35	60	...	...	...	...	11	16	67.6	21.6	53.3
Black blasting powder	...	...	73	...	...	...	...	...	...	71.6	6.8	58.6

a Wood pulp, flour and sulphur.
b Wood pulp only.
c Sulphur, coal and resin.

pushing action and less percussive force, will be more suitable. The tests also show that 60% strength low-freezing dynamite is not quite equivalent to the 40% straight nitroglycerin dynamite. It is worthy of note that black blasting powder has little disruptive effect, only about one-third that of granulated nitroglycerin powder.

BLASTING WITH LIQUID AIR

The first attempts to use liquid air as an explosive were made at an early stage of the liquid air industry. In fact, shortly after the invention of his process, Prof. von Linde (in 1897), by mixing liquid air with charcoal, succeeded in producing an explosive which he termed "oxyliquite." This pulpy explosive was introduced directly into the blast hole and ignited by means of cartridges and fuses. As, however, this primitive process failed to give any satisfactory results, the explosive mass was filled into carefully prepared paper cylinders (preferably immerced entirely into liquid air), which were then introduced into the blast hole. Though sufficient explosive effects were thus obtained in most cases, this process did not warrant anything like real safety and depended in an extraordinary degree on the skill of the men and the rapidity of working.

These unsatisfactory results are due on one hand to the physical properties of liquid air itself and on the other to the imperfect process used in preparing the explosives. Liquid air at ordinary atmospheric pressure, i. e., in the open air, of course possesses a temperature of—191 deg. Cent. (—311.8 deg. Fahr.) and liquid oxygen a temperature of—182 deg. Cent. (—295.6 deg. Fahr.), the temperature difference as compared with the surrounding rock thus being about 200 deg. Cent. (360 deg. Fahr.). It will thus be readily understood that a lively exchange of temperature by heat conduction and radiation should be set up between the explosive and its surroundings, the liquid air in the blast hole being vaporized most rapidly by the absorbed heat. In fact, the explosive cartridges used in connection with these early experiments were found to possess a maximum life of 10 minutes at the outside, their efficiency being considerably reduced even after a shorter life.

After being discontinued for many years, these experiments were recently taken up again by a German mining engineer, Mr. Kowastch, who in conjunction with Mr. Baldus, of Charlottenburg, was allowed to work at the Royal Quarries of Rüdersdorf, near Berlin. In accordance with the above, Mr. Kowastch tried to prevent the liquid air in the blast hole from evaporating by any possibility beyond a given limit. He therefore conceived the idea of introducing the cartridge with the dry carbon holder separately into the blast hole without the liquid air, and afterward making any mining preparations (tamping the blast hole, etc.), waiting until the very last moment to add the liquid air and igniting the mixture immediately afterward. This process obviously allows the time of vaporization to be reduced to a minimum, thus saving much of the liquid air otherwise required, cheapening the process and warranting an incomparably higher safety.

A substantial pasteboard cylinder containing a perforated distribution tube and filled with an absolutely inert mixture of kieselguhr and oil, asphalt, soot, or paraffin, is introduced into the blast hole. Into the central distribution tube is introduced a thin supply tube (of paper) over which another paper tube for discharging any products of vaporization of the liquid air is slipped, after which the tamping can be safely proceeded with. Whenever several blast holes are to be fired simultaneously, the electrical conductors are properly connected with one another and with the igniting battery.

The liquid air is kept ready for each blast hole in a special small flask containing a weighed quantity. These flasks carry at their opening a flexible metal tube with conical point into which the central supply tube is fitted. All that is required for charging then is to lift the back end of the flask, when the liquid air, under the pressure of its own products of vaporization (like mineral water under the pressure of carbonic acid) rises through the metal tube into the supply tube and through this into the cartridge, entering there between the individual particles of the charge, ready at the very moment explosion is started by electric ignition, to combine with the components of the cartridge in an explosion of terrific violence. The completion of the charge is readily ascertained by the cessation of the fizzing noise under which part of the liquid air escapes from the blast hole as a white fume.

This process thus eliminates all the difficulties experienced in early attempts to use liquid air as an explosive. Being readily prepared by a cheap process at the place of consumption, in fact, in the very gallery where it is to be used, it does away with the lamentable accidents inseparable from the transport and storage of dynamite above or below ground. Furthermore, there is no possibility of the explosive's being stolen, e. g., for unlawful purposes, nor is the manufacture of the explosive itself connected with any danger, while the presence of considerable amounts of oxygen in the form of liquid air is a valuable addition to the salvage arrangements of the mine.

By using the cheap fuel available in coal mines, the operation of a liquefaction plant will be cheapened sufficiently for liquid air to compete successfully with the ordinary explosives.—*Scientific American.*

HAND DRILLING RECORDS

The following records of hand drilling are worth preserving for the purpose of comparison. It is much to be regretted that the diameters of holes drilled and generally the kind of rock are not given.

SINGLE HAND RECORDS.

These three records were all made at the Midwinter fair, San Francisco, 1894:

E. F. Durham, Grass Valley, Cal., 19 31-32 inches, in 10 minutes.

T. J. Ahearn, Grass Valley, Cal., 19 9-16 inches, in 10 minutes.

D. L. Jones, Denver, Col., 18 11-16 inches, in 10 minutes.

DOUBLE-HAND RECORDS.

Moore and Butler, Pony, Mont., July 4, 1898, 32 inches, in 10 minutes.

Page and Wainwright, Sonora, at Stent, Cal., Sept. 9, 1899, 37 15-16 inches, in 10 minutes.

Bradshaw and Freethey, Butte, at Spokane, Sept. 24, 1901, 55 inches, in 15 minutes.

Ross and McLeod, British Columbia, at Spokane, Sept. 24, 1901, 51 inches, in 15 minutes.

Page and Pickens, at Tonopah, July 4, 1912, 45 7-16 inches, in 15 minutes. (In Roklin granite, 66 blows per minute).

Lindquist and Dahlen, Victor, Col., at Tonopah, July 4, 1912, 41 7-16 inches, in 15 minutes.

Porter and Goddard, Oatman, Ariz., at Tonopah, July 4, 1912, 38-7-16 inches, in 15 minutes.

Stewart and Carmack, Leadville, at Quarto-centennial, Colorado Springs, August, 1901, 46 plus inches, in 15 minutes. (Drilled through block of Gunnison granite in 14 minutes 30 seconds).

Hupps and Lindquist, Ouray, Col., at Quarto-centennial, Colorado Springs, August, 1901, 43⅜inches, in 15 minutes.

Chamberlain and Malloy, Leadville, at Quarter-centennial, Colorado Springs, August, 1901, 41¼ inches, in 15 minutes.

McNichols and Lamb, Victor, Col., at Quarto-centennial, Colorado Springs, August, 1901, 41⅛ inches, in 15 minutes. (Previous local record said to be 39⅞ inches).

Names not given at Calumet, Mich., Aug. 24, 1912, 49 inches, in 15 minutes.

THREE HAND RECORDS.

Page, Kitto and Dingle, Grass Valley, Cal., at Jubilee fair, San Francisco, Feb. 22, 1898, 41⅛ inches, in 15 minutes.

Feeney brothers and Larkin, Grass Valley, at Jubilee fair, San Francisco, 36¾ inches, in 15 minutes.

Page, Kitto and Harvey, Amador, at Midwinter fair, San Francisco, 1894, 42 inches, in 15 minutes. (Forty inches through a block and two inches in a fresh hole).

Feeney brothers and Lynch, at Midwinter fair, San Francisco, 1894, 39 inches, in 15 minutes.

Amalgamated team, Butte, at Hancock, Mich., July 4, 1911, 59 inches, in 15 minutes.

Amalgamated team, Butte, at Calumet, Mich., Aug. 4, 1911, 59½ inches, in 15 minutes.

NOTES

In the treatment of pitchblend by the Austrian Radium Institute, it takes 10 tons of ore to yield approximately 1 gram of radium bromide. To obtain this there are 5½ tons of chemicals and 55 tons of water used, and there are over a thousand crystallizations made, each requiring from a few hours to several days.

New York City will soon have under simultaneous construction new subway and elevated lines for the Dual System of rapid transit to cost upwards of $81,000,000. This work covers about 27 miles of new railroad, with

nearly 100 miles of track, as almost all the work is 4 track line. About 21 miles will be subway and 6 miles elevated. The work will be done by 14 contracting firms employing over 6000 men.

It is proposed to hold at Earls Court, London, from March 24 to April 4, 1914, an International Oil Industries Exhibition, which it is stated is receiving the support of the Governments of most oil producing countries. The exhibits will comprise oil-field equipment, transport facilities, refining plant, fuel systems and appliances, engines for power, etc., lighting and heating apparatus, etc.

In order to protect the valuable records of the Government from danger by fire Congress has made an appropriation for the installation of a modern system of auxiliary fire protection for three of the largest buildings occupied by the Department of the Interior in the city of Washington. A committee has been appointed to investigate the relative merits of systems adaptable to the buildings of the Department and to prepare plans and specifications. All communications regarding the subject should be addressed to the Chief Clerk of the Interior Department, Washington, D. C.

During 1912 a standpipe at the pumping station of the Harrisburg, Pa., waterworks, which had been used for equalizing pressure and was in need of repair, was modified in an unusual way, and made to serve as an air pressure chamber for the pumping engines. A manhole was put in the standpipe and a steel head or diaphram was riveted in several feet above the bottom. The bottom of the standpipe was then connected with the discharge pipes of the two old pumping engines and the air pressure served the same purpose of maintaining the water pressure which had previously been done by the height of the water in the standpipe.

The use of liquid air to attain high temperatures in metallurgical work is commented upon favorably in a recent issue of *Echo des Mines*. At Ougrée-Maripaye a Thomas furnace is said to be worked by injecting liquid oxygen under pressure, into the hearth, where it raises the heat to 2000° C. The reactions take place quickly without any change in the *modus operandi* usual in the making of steel. Large quantities can be treated, as with coal or coke, in a much easier manner than can be done in an electric furnace. The fusion time is reduced one-half, and a furnace can double its output, although there is some trouble in maintaining the furnace walls with such high temperatures.

An under-tired truck will cause only trouble and expense. Tire makers are ready to furnish eight by thirty-eight inch pneumatic tires which carry a normal air pressure of 160 pounds per square inch. A tire of this size will support a static load of 4000 pounds with a deflection of less than one-half inch, and is rated at 2000 to 2200 pounds capacity.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 3.

1,063,191. MACHINE FOR APPLYING CLOSURES TO BOTTLES. BERNARD GALLAGHER, Lynn, Mass.

1. A machine for applying closures to bottles, having, in combination, two members constituting a closure-applying head and a bottle support, and means for supporting said members and for moving one member toward the other to affix a closure to a bottle on the bottle support, said means including a pneumatic-pressure device operated by said movement, and means for adjusting the initial distance between said members to vary the pressure transmitted by the pneumatic-pressure device, substantially as described.

1,063,194. ENGINE FOR ROCK-DRILLS. GEORGE H. GILMAN, Claremont, N. H.

1,063,240. IMPACT-ENGINE. GEORGE R. BENNETT, Denver, Colo.

1,063,407. PNEUMATIC HORSE-COLLAR. FRED BATCHELER, Bomarton, Tex.

1,063,558. PREVENTING PULSATIONS IN CENTRIFUGAL AIR-COMPRESSORS. LOUIS C. LOEWENSTEIN, Lynn, Mass.

1,063,583. AIR-PURIFYING DEVICE FOR CREAMERY-VATS. FRANK R. NOONAN, Alexandria, Minn.

1,063,596. SEMI-AUTOMATIC BLAST-GATE FOR CENTRIFUGAL COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

1,063,624. TYPE-WRITING MACHINE. CHARLES H. VOGEL, Vancouver, British Columbia, Canada.

1. A typewriting machine having a carriage in combination with a pneumatic cylinder, a piston rod actuated thereby and attached to said carriage, a valve co-operating with said cylinder, means for normally holding said valve in a position to cause said piston rod to advance said carriage in the letter-feeding direction, a key for actuating said valve to cause said piston rod to move said carriage in the reverse direction, and means to return the key and valve whenever the key is released whereby the point at which the return movement of the carriage is arrested is under the control of the operator.

1,063,626. APPARATUS FOR MEASURING THE THRUST OR PULL ON SHAFTS. PAUL WAGNER, Charlottenburg, Germany.

1. In apparatus of the class described, the combination of two shafts arranged in substantially axial alinement and having the end of one adjacent to the end of the other, a member carried by the end of one shaft, a member carried by the end of the other shaft in sliding engagement with the first member, there being a pressure chamber between said members to which fluid under pressure can be supplied, and means for transmitting rotary motion from one member to the other without interfering with the relative axial movement of the members.

1,063,636. METHOD OF AND APPARATUS FOR FORCING OR COMPRESSING FLUIDS. ALFRED BARBEZAT, Paris, France.

1. The method of forcing or compressing a fluid which consists of heating a portion of the stream of fluid to decrease its density, accelerating the velocity of the cooler and denser portion of the stream by centrifugal action due to rotating said portion before it is heated, and causing this denser portion at relatively high velocity to act upon the less dense heated portion.

1,063,666. INTERNAL-COMBUSTION TOOL. OTHO C. DURYEA and MORRIS C. WHITE, Los Angeles, Cal.

1,063,667. HAMMERING IMPLEMENT. OTHO C. DURYEA and MORRIS C. WHITE, Chicago, Ill.

1. In a hammering implement, a tool-carrying casing, a piston therein, means for reciprocating the piston by fluid under pressure, including an expansion chamber in which the fluid operates against the piston from one direction, an explosion chamber in the casing into which said fluid is exhausted from the expansion chamber and compressed by the piston, and means for causing an explosion in said last mentioned chamber while the fluid is under compression.

1,063,708. PROCESS OF REFINING BROWN SUGAR. UNO LUNDGREN and GUILLAUME GIERLING, Brussels, Belgium.

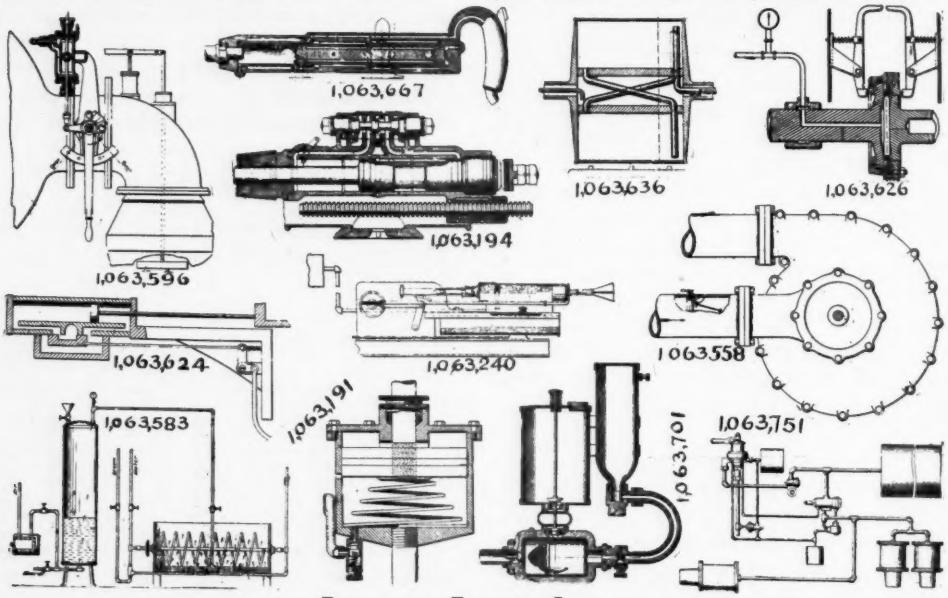
1. In the art of refining sugar, the process which consists in bleaching a cold solution of sugar of a density of substantially 20 degrees Baume by subjecting it to the action of ozone or ozonized air.

1,063,751. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.

1,063,898. PNEUMATICALLY-CONTROLLED MUSIC-PLAYING DEVICE. PETER WELIN, Newcastle, Ind.

1,063,901. GAS-ENGINE STARTER. ELWOOD C. ALLISON, Brooklyn, N. Y.

1. A gas engine starter including a fuel reservoir, a measuring tank communicating therewith, and having an outlet port, a carbureter communicating with said outlet port and having a mixture outlet port and an air intake port on opposite sides of said measuring tank outlet port, a compressed air reservoir communicating with said air intake port, means for manually establishing communication between said measuring chamber and said carbureter, and other means for manually establishing communication between said air reservoir and said carbureter.



PNEUMATIC PATENTS JUNE 3.

JUNE 10.

1,063,946. APPARATUS FOR TESTING AIR OR OTHER GASES. MAX ARNDT, Aix-la-Chapelle, Germany.

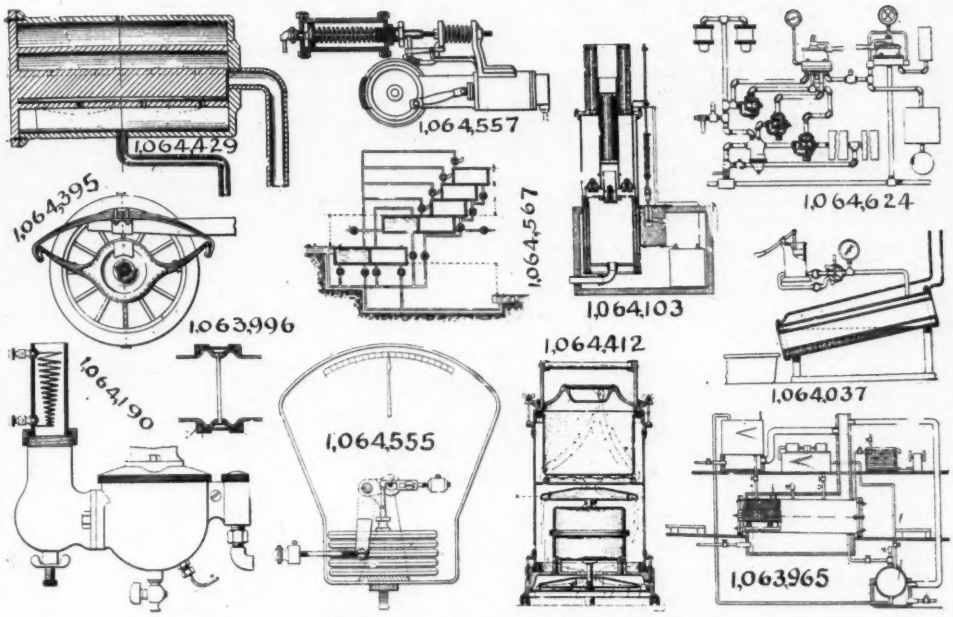
1,063,965. APPARATUS FOR TREATING PAVING-BLOCKS. CLAUD E. FULLER, Buffalo, Kans.

1. In an apparatus for treating paving blocks, an immersing chamber, a supply tank disposed higher than the chamber, a conductor connecting the tank and chamber, a drain receptacle disposed lower than the chamber, a conductor connecting the chamber and the said receptacle, an air compressor, a conductor connecting the compressor and the chamber, shut off valves located in said conductors respectively, a conductor connecting the compressor and the receptacle, and a conductor connecting the receptacle and the tank.

1,063,996. MECHANICAL JOINT FOR VACUUM-TUBES. DANIEL MCFARLAN MOORE, Newark, N. J.

1,064,037. MEANS FOR PROVIDING CONSTANT AND KNOWN HIGH TEMPERATURES. WILLIS R. WHITNEY, Schenectady, N. Y.

1. A heating device, consisting of the combination of a closed chamber, a vaporizable sub-



PNEUMATIC PATENTS JUNE 10.

stance therein, means for heating said substance, and a pump for establishing at any desired value the gaseous pressure in said chamber and thereby fixing at will the vaporizing point of said substance.

1,064,103. ELECTRIC AIR - COMPRESSOR. STEPHEN P. SMITH, Berkeley, and CHARLES W. KEIVER, Oakland, Cal.

1,064,190. ELECTRIC AIR-HEATER. LESTER A. BILL, Cambridge, Mass.

1,064,395. PNEUMATIC CUSHIONING DEVICE FOR VEHICLES. CHARLES L. SUTTON, Oakland, Iowa.

1,064,412. VACUUM - CLEANER. WALTER THOMAS WHITE, St. John, New Brunswick, Canada.

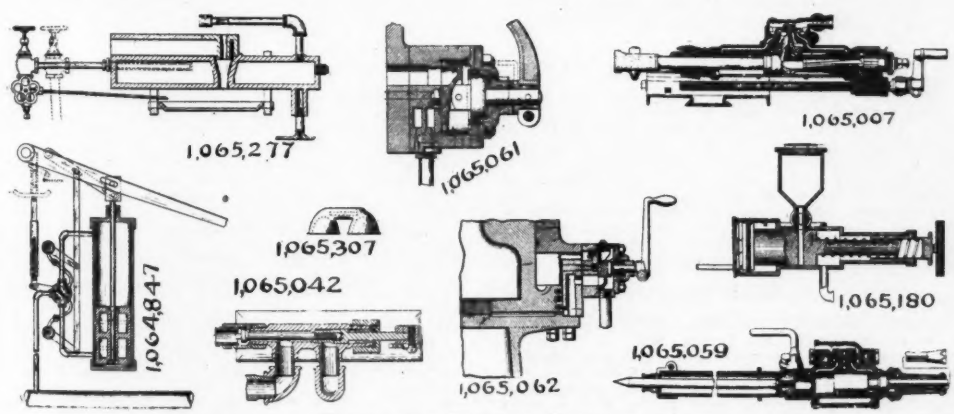
1,064,429. AIR AND OIL SEPARATOR FOR AIR-COMPRESSORS. AUGUST FRED BERGHAHN, Belleville, Ill.

1,064,555. VACUUM OR PRESSURE GAGE. JOHN F. SIMMANCE and JACQUES ABADY, London, England.

1,064,557. MEANS FOR PRODUCING AND CONTROLLING PNEUMATIC PRESSURE. HARRY SMITH, Harpers Ferry, Iowa.

1. The herein described mechanism for the purpose specified the same consisting of a cylinder, a piston arranged to operate therein, means for moving the piston in one direction, a spring for moving the piston in an opposite direction, a stop, a spring acting on the stop to hold it in a given position, a lock for holding the stop when moved by the said piston, and a trip connected with the piston for disengaging the lock from the stop.

1,064,567. PROCESS AND APPARATUS FOR AUTOMATICALLY RAISING WATER. GUSTAV TIEDTKE, Dortmund, Germany.



PNEUMATIC PATENTS JUNE 17.

1,064,624. AIR-BRAKE SYSTEM. FRANK H. DUKESMITH, Buffalo, N. Y.

JUNE 17.

1,064,783. PNEUMATIC CLEANING DEVICE. JAMES M. SPANGLER, Canton, Ohio.

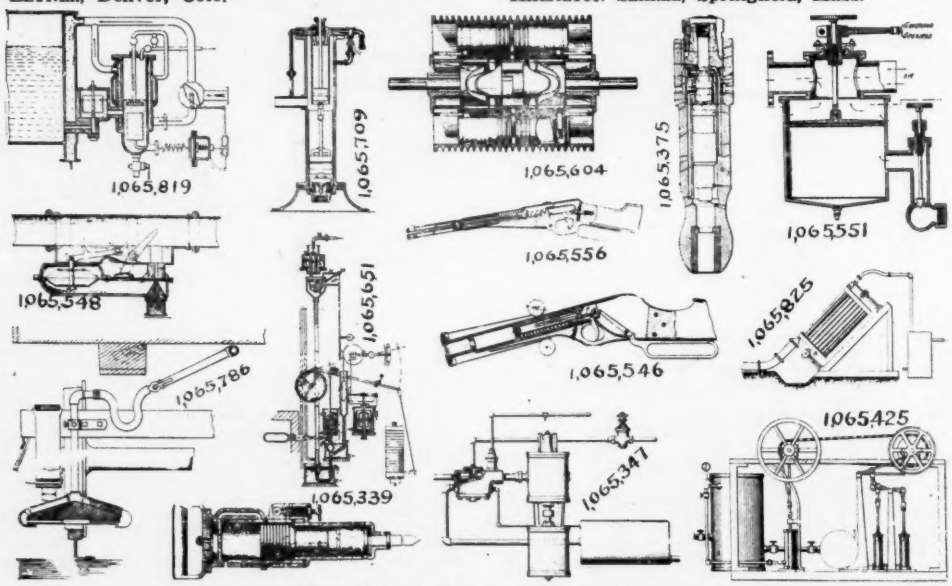
1,064,847. PNEUMATIC ELEVATOR - DOOR CONTROLLER. EDWARD N. MILLS, San Francisco, Cal.

1,065,007. ROCK-DRILL. JAMES A. THOMPSON and EDWIN M. MACKIE, Chicago, Ill.

1,065,042. VALVE FOR AUTOMATIC HYDRAULIC AIR-COMPRESSOR-OPERATING SYSTEMS. ARTHUR GRANDJEAN, San Diego, Cal.

1,065,059. PNEUMATIC FEEDING DEVICE FOR STOPING-DRILLS. JOHN GEORGE LEYNER, Denver, Colo.

1,065,061. MULTIPLE-FUNCTION CONTROLLING THROTTLE-VALVE. JOHN GEORGE LEYNER, Denver, Colo.



PNEUMATIC PATENTS JUNE 24.

1,065,062. TRIPLE-PURPOSE VALVE FOR DRILL - BIT - SHARPENING MACHINES. JOHN GEORGE LEYNER, Denver, Colo.

1,065,180. GRAPHITE LUBRICATOR. LELAND D. SMITH, Louisville, Ky.

1,065,277. HYDROCARBON - OIL BURNER. GEORGE R. SHANKLIN, Portland, Oreg.

1,065,307. VACUUM STICKER OR ATTACHING DEVICE. JAMES P. EVERTTS, Sayre, Pa.

1. A vacuum sticker comprising spaced rubber vacuum cups arranged to engage a surface and be retained in position by vacuum, and a member connecting said cups comprising an elongated integral extension of said cups, and said member being relatively thin and yieldable, whereby the cups may be positioned out of alinement to engage different surfaces, substantially as and for the purpose described.

JUNE 24.

1,065,339. SINGLE-ACTING ENGINE. BENJAMIN BRAZELLE, St. Louis, Mo.

1. In a fluid-pressure engine, the combination with a cylinder having an air supply port, an air cut-off port, and an air outlet port, of a sleeve valve controlling said ports, and a solid piston sliding within said valve, the movement of said piston operating to close said cut off port.

1,065,347. STEAM - CONTROLLING APPARATUS. JOHN F. DEEMS, Burlington, Iowa.

1,065,375. PNEUMATIC TOOL. HENRY E. LE GENDRE, Cresskill, N. J., and GEORGE LEICH, New York, N. Y.

1,065,425. COMPRESSED-AIR MOTOR. IGNAC BASINSKI, Chicago, Ill.

1,065,499. MACHINE FOR BLOWING GLASS BOTTLES, JARS, AND THE LIKE. ALBERT BEVERLEY, Gorringe Park, Mitcham, England.

1,065,546. PNEUMATIC GUN. JAMES A. PACKARD, Milwaukee, Wis.

1,065,548. AUTOMATIC CARRIER SEPARATOR AND DESPATCHER FOR PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,065,551. GAS AND AIR MIXER. JOHN D. RUSS, Spencer, W. Va.

1,065,556. MAGAZINE AIR-RIFLE. ELBERT HAMILTON SEARLE, Springfield, Mass.

1,065,604. FLUID-MOTOR. THOMAS J. GRAY, Chicago, Ill.

1,065,649. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.

1,065,651. AIR-PYROMETER. MAX ARNDT, Aix-la-Chapelle, Germany.

1,065,709. PUMP. PHILIP A. MYERS, Ashland, Ohio.

1. A pump comprising two cylinders of different diameters arranged longitudinally one within the other, the larger cylinder being formed with a water inlet and a water outlet, the inner cylinder having one end in open communication with the larger cylinder and having its other end closed and formed with air inlet and outlet passages, a single piston-rod operating in said cylinders, and pistons carried by said rod and operating in the respective cylinders whereby the piston in the larger cylinder will pump water, and the piston in the smaller cylinder will pump air on one side and water on the other side thereof.

1,065,786. RAILWAY SAFETY DEVICE. SAMUEL G. DAVIS, Horatio, Ark.

1,065,819. DEVICE FOR CARBURETING AIR. GASTON PAUL JEAN LION, Levallois-Perret, France.

1,065,825. ELASTIC-FLUID COMPRESSOR. GEORGE C. MCFARLANE, Denver, Colo.